TRAINING SCHOOL

MOTOROLA Communications and Electronics Inc.

TECHNICAL TRAINING DEPARTMENT

NATIONAL
MOTOROLA
COMMUNICATIONS
SERVICE

COURSE NO. PG

"HT 220 & HT 100"

"HANDIE-TALKIE"

FM PORTABLE RADIO

TECHNICAL
TRAINING
DEPARTMENT

COURSE NO. PG

"HT 220 & HT 100"
"HANDIE-TALKIE"
FM PORTABLE RADIO

MOTOROLA COMMUNICATIONS AND ELECTRONICS INC. A SUBSIDIARY OF MOTOROLA, INC.

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PG

TECHNICAL TRAINING DEPARTMENT

"HT 220" AND "HT 100" "HANDIE TALKIE" FM PORTABLE RADIO

COURSE No. PG

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PART I – INTRODUCTION

Course No. PG has been designed to cover the "Handie-Talkie" FM Portable radio, high band models, HT-220 and HT-100 Series.

The text contains sections devoted to the Theory of Operation of the HT-220 and HT-100 Series portable radio with particular emphasis on the latest and most advanced circuitry, such as the use of a ceramic filter as the 455 KHz filter, integrated circuits used in the transmitter and receiver, and advanced designed squelch and audio circuits.

The servicing section of the text is devoted to servicing procedures, measurements, techniques, and proper techniques in repairing the unit. It contains complete schematics and printed circuit board diagrams marked with servicing measurements and locations to aid the Technician in troubleshooting the HT-220 and HT-100 Portable two-way radio.

The material contained in this course is designed, primarily, for a one day school with demonstrations and bench work on live equipment.

However, when time does not permit a full one day school, an evening session may be conducted. The Motorola instructor has available a special curriculum for Course PG which will allow him to conduct this course in a minimum of four (4) hours. This curriculum makes maximum use of color slides, especially in lieu of live demonstrations of servicing methods and techniques.

A thorough knowledge of the information contained in Course PG will greatly increase the Technician's proficiency in servicing the HT-220 and HT-100 series of "Handie-Talkie" FM portable radio.

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"HT 220" AND "HT 100" "HANDIE TALKIE" FM PORTABLE RADIO

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1. Front & Back Covers Are Removable with the Front Cover Having Plug or Pin Connectors

2. The Use of Integrated Circuits Replaces Complete Sections of the Radio. One IC is Located in the Receiver and One IC is Located in the Transmitter.

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H. ADDITIONAL REFERENCE MATERIAL

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PART III—LIST OF EQUIPMENT

A. EQUIPMENT DISCUSSED

1. HT220 Series Handie-Talkie FM Radio, H23FFM
2. HT100 Series Handie-Talkie FM Radio, H13FFN

B. SUGGESTED TEST EQUIPMENT

All the required test equipment needed for aligning and testing the "Handie-Talkie" Radio Set described in this manual is listed in the following Test Equipment Chart. The listed items or their equivalents may be used.

TEST EQUIPMENT CHART

EQUIPMENT	PURPOSE
Motorola DC Multimeter with rf probe.	All dc and rf measurements. Monitoring input current when external power supply is used.
Motorola AC Voltmeter S1051-C.	All ac signal measurements.
Oscilloscope - Motorola T1015A General Purpose or S1301 Precision Wide-Band	IDC Adjustment.
455 KHz Crystal-Controlled Oscillator - Motorola S1056A-9A Series Test Set with 455 KHz crystal.	Alignment of 455 KHz i-f filter, limiter, and discriminator stages.
RF Wattmeter, 50 ohms impedance.	RF Output power measurements.
DC power supply capable of supplying 15 vdc at 1 ampere. Motorola TEK-23.	Supplying dc power to the unit during extended servicing.
Motorola TEK-10RF injection probe.	Stage gain measurements.
Motorola NEN6072A Test Jig with NKD6001A Tune-up Cable.	To hold the radio set for alignment or testing, keeping the push-to-talk button depressed, applying external power.
Motorola NLN6689A Alignment Tool (supplied with the radio set).	Adjusting the tuning coil slugs.
Motorola T1034B Signal Generator	Generating frequencies.
Motorola S1078A Digital Frequency and Deviation Meter.	Checking frequencies and deviation.
Motorola TEK-1A Solid-State Tone Generator.	1000 Hz test tone frequency.

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"HANDIE TALKIE" FM PORTABLE RADIO

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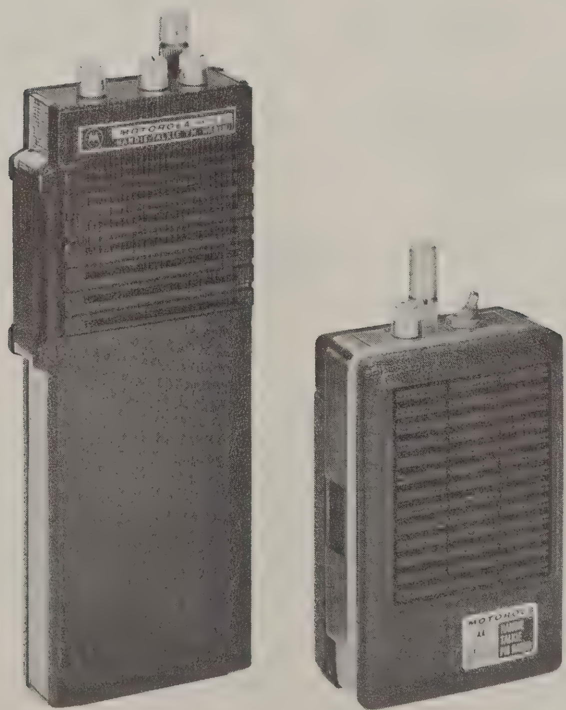
TEXT



GUARANTEED PERFORMANCE SPECIFICATIONS

GENERAL

MODEL	H23FFN Series
POWER SUPPLY	(1) Mercury battery, or (1) nickel-cadmium battery
BATTERY DRAIN Standby Receive Transmit	 4.3 ma at 15.0 volts dc 65 ma at 15.0 volts dc 310 ma at 15.0 volts dc
BATTERY LIFE (Based on 5% transmit, 5% receive with rated af output, 90% standby)	Mercury battery, 46 hours Nickel-cadmium battery, 8 hours/charge
DIMENSIONS (ht x width x depth)	6.95" x 2.75" x 1.16" (less knobs and antenna)
WEIGHT	20.5 ounces (with mercury battery) 21.0 ounces (with nickel-cadmium battery)

TRANSMITTER

RF OUTPUT (Mercury battery) (Nickel-cadmium battery)	 1.0 watt at 12.7 volts dc 1.8 watt at 15.0 volts dc
FREQUENCY STABILITY	±.0005% from -10°C to +50°C, ±.0015% from -30°C to +60°C (25° reference)
MODULATION	Type 16F3, ±5kHz for 100% modulation at 1000 Hz
CRYSTAL MULT.	9 times
SPURIOUS & HARMONICS	More than -46 db below carrier
FM NOISE	At least 40 db below ±3.3kHz deviation at 1000 Hz
AUDIO RESPONSE	+1, -3 db from 6db/octave pre-emphasis characteristic from 300-3000 Hz
AUDIO DISTORTION	Less than 10% at 1000 Hz, 2/3 max. rated deviation
MAX. PERMISSIBLE CHANNEL SEP.	1 MHz, no degradation
FREQUENCY RANGE	150.8-174 MHz

RECEIVER

AUDIO OUTPUT	500 mw at less than 10% distortion
FREQUENCY STABILITY	±.0010% from -10°C to +50°C, ±.0015% from -30°C to +60°C (+25° reference)
MODULATION ACCEPTANCE	±8 kHz
SPURIOUS & IMAGE REJECTION	More than 50 db below carrier
SENSITIVITY	.25 uv (12 db Sinad), .35 uv max. (20 db quieting)
SELECTIVITY	More than 70 db at ±30 kHz (20 db quieting) More than 60 db at ±30 kHz (EIA Sinad)
NOISE SQUELCH SENSITIVITY	Noise compensated type, adjustable, will open at less than .18 uv
MAX. PERMISSIBLE CHANNEL SEP.	1 MHz (no degradation)
INTERMODULATION	More than 50 db at adjacent channel
CHANNEL SPACING	30 kHz
FREQUENCY RANGE	150.8-174 MHz

FCC LICENSE DESIGNATION: CC3526
(SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE)

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TECHNICAL TRAINING DEPARTMENT

"HT 220" AND "HT 100" "HANDIE TALKIE" FM PORTABLE RADIO

COURSE No. PG

I.

A. INTRODUCTION

The H23FFN and the H13FFN Series of completely solid state Motorola "Handie-Talkie" FM Radio Sets are described in this training package. They can be held in the hand or clipped to the belt or shirt pocket. Powered by mercury or nickel-cadmium batteries, they are capable of dependable two-way communication with any compatible FM radio set within range.

Models are available in both single frequency and dual frequency. The HT is available with several different types of antennas.

Miniaturized circuitry is utilized in these radio sets and the introduction of integrated circuit modules in this series of models assures the user of the latest in circuit design features which inject added dependability and long service life.

B. GUARANTEED PERFORMANCE SPECIFICATIONS

II. EQUIPMENT - MODELS, FEATURES AND OPTIONS

A. GENERAL

Two basic models of the HT series of "Handie-Talkie" FM portable radio will be discussed, the e HT220 and HT100 series.

The receiver circuits are the same for both models, the transmitter circuits are identical except for the final output circuitry.

Both series of units operate in the 150. 8 MHz range. However, only the HT220 version will be discussed extensively.

B. RUGGED CONSTRUCTION

The separate transmitter and receiver sections are built on an entirely new glass epoxy circuit board. The I-beam metal frame surrounds all components protecting them from damage. The high impact plastic housing protects the unit, and is designed to withstand damaging blows.

C. ULTRA COMPACT AND LIGHTWEIGHT

At a mere 21 ounces you can easily slip the HT220 into a pocket, clip it to your belt, or wear it with a carrying case.

The HT100, a smaller, and still a lighter unit than the HT220 is only 15 ounces and fits in the palm of your hand or in your shirt pocket like a pack of cigarettes.

D. VERSATILE CAPABILITIES

Available accessories include carrying cases, nickel-cadmium or mercury batteries, several different types of antennas, such as a collapsible whip, a flexible wire, or rigid loop antenna. All controls are mounted for easy-to-operate convenience.

E. PROVIDES PERSONAL TWO-WAY COMMUNICATIONS

The latest state-of-the-art in a personal 2-way radio, is available in single or dual frequencies. All controls are mounted for easy and convenient operation, and because the unit is much smaller and lighter than any other model in our line it provides for maximum portability.

F. FULLY TRANSISTORIZED TRANSMITTER & RECEIVER

Complete operating dependability and top performance is achieved by utilizing the latest state-of-the-art circuit design.

G. THE USE OF INTEGRATED CIRCUITS

The utilization of integrated circuits and high density component design achieves optimum space reduction.

H. CERAMIC FILTER INSTEAD OF A PERMAKAY

The use of a ceramic filter instead of a Permakay filter is again the result of the utilization of the latest

state-of-the-art in component design. The ultimate goal in portable radios is miniaturization.

I. A NEW ADVANCED SQUELCH AND AUDIO CIRCUIT

A new squelch circuit provides a quick, positive acting squelch, and practically eliminates any squelch tail at the end of a transmission.

The audio section of the receiver uses an advanced technique for filtering all frequencies below 300 Hz.

J. TRANSMITTER FREQUENCY MODULATION

The HT220 and HT100 use direct FM rather than Phase modulation, which is the modulation of the carrier frequency by applying the audio to the oscillator stage. This type of modulation is referred to as frequency modulation.

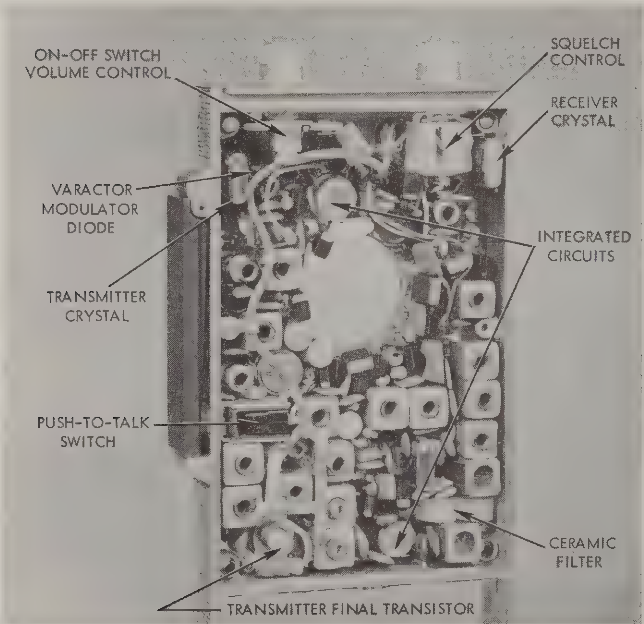


Figure 1.

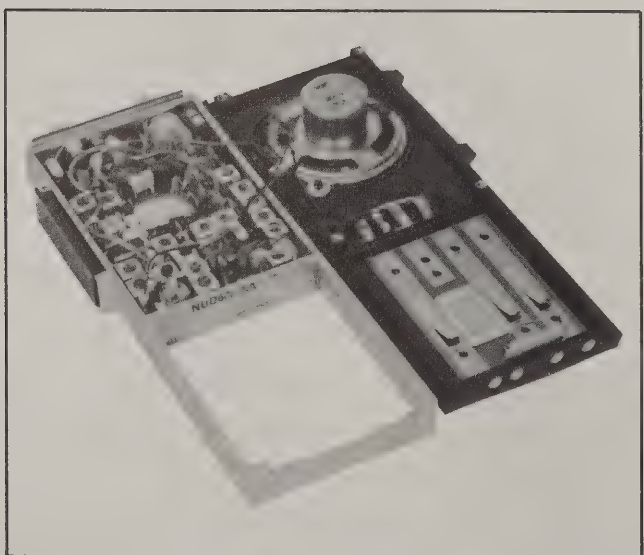


Figure 2.

K. PUSH-TO-TALK SWITCH

The push-to-talk switch is a small microswitch which is used to switch the RF signal and DC voltages between the receiver and transmitter.

L. RECEIVER AUDIO LEVEL AND TRANSMITTER RF POWER OUTPUT

MILLI
The audio output of the receiver is 500 watts at less than 10% distortion.

The transmitter power output is 1.8 watts for the HT220 and 0.5 watts for the HT100 which will provide good dependable communications depending on the applications.

Figure 3.

DISASSEMBLY PROCEDURE FOR THE REMOVAL OF THE PUSH-TO-TALK SWITCH.

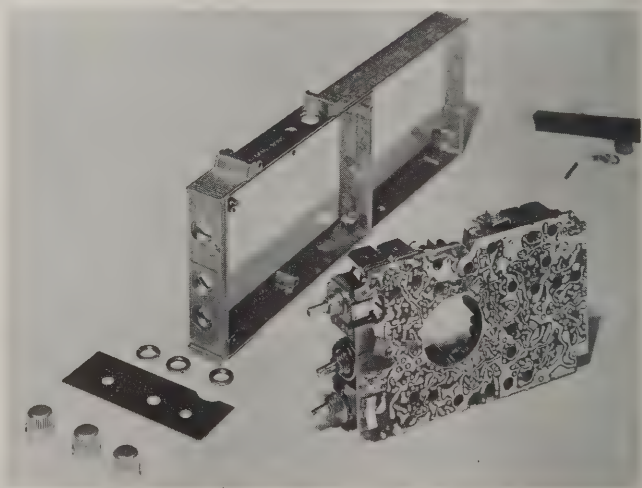


Figure 4.

DISASSEMBLY OF THE COMPLETE HOUSING.

III. THEORY OF OPERATION

A. GENERAL

This Series of "Handie-Talkie" FM Radio Sets consists of a crystal controlled transmitter and receiver operating in the 150.8-174 MHz frequency range.

The transmitter contains an audio section and an RF section. The audio section consists of a speaker-microphone, and an integrated circuit Instantaneous Deviation Control (IDC) circuit. The RF section includes a crystal controlled oscillator, varactor modulator, two frequency tripler stages, a driver amplifier, and a final amplifier stage.

The receiver is a dual conversion, super-heterodyne type of unit, consisting of an rf amplifier, two oscillators, two mixers, a 455 KHz filter, a 455 KHz integrated circuit i-f amplifier, a limiter stage, discriminator stage, squelch amplifier, squelch limiter, audio amplifier, audio driver, final amplifier, and speaker.

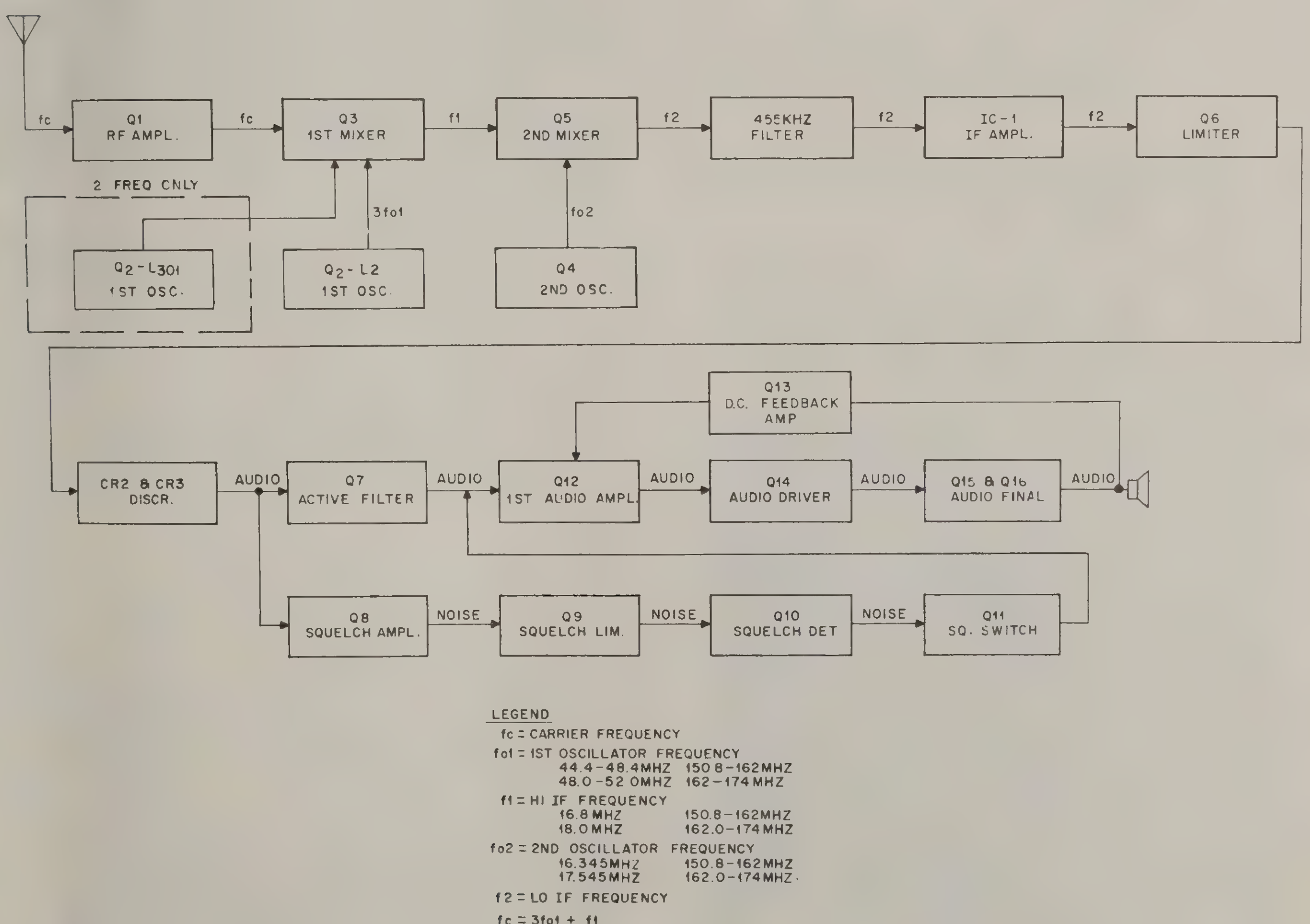
B. RECEIVER DETAILED CIRCUIT ANALYSIS

1. Receiver General Description

The RF signal from the antenna is coupled to RF amplifier Q1 where it is amplified and then injected into the first mixer Q3. The first mixer has another input and it is the first oscillator Q2 signal which is mixed with the carrier frequency to produce a difference frequency which is the high (or 1st) IF frequency.

The high IF signal is then coupled into the 2nd mixer Q5. The second mixer also has a second input from the low oscillator which is mixed with the high IF frequency to produce a difference frequency that will be the low IF frequency of 455 KHz.

The low IF signal passes on into the 455 KHz ceramic filter and is then fed into the integrated circuit module IC1. After being amplified by IC1, the IF signal is coupled to the limiter where any amplitude modulation of the signal is removed.



RECEIVER BLOCK DIAGRAM

Figure 5.

The limited signal is then fed to the discriminator stage where the frequency variations of the incoming signal are translated into an audio signal and this signal is then filtered and amplified further by the Audio Amplifier Stages.

The squelch circuitry mutes the receiver during the intervals between messages, thus preventing the normal no-signal noise from being heard at the speaker. The squelch circuitry takes high frequency noise signals from the discriminator stage through a high-pass filter, amplifies it, and converts it to a DC voltage which operates the squelch switch stage which in turn squelches (or mutes) the receiver. When the receiver senses an on-channel signal, the noise decreases, thus reducing the DC voltage at the input of the squelch switch stage which in turn opens the switch and turns on the Audio stages.

2. Antenna

a. Characteristics

The HT220 and HT100 antenna is available in several different completely interchangeable varieties listed below.

(1) Collapsible Whip - Most popular as it provides maximum radiated output, yet stores itself completely out of the way when not in use.

(2) Flexible Whip Antenna - Especially useful where ruggedness and flexibility are important.

(3) Tilted Whip Antenna - Used primarily with remote microphone units worn on a belt. The tilted whip keeps the antenna from being in close proximity with the user's body.

Figure 6. .

(4) Rigid Loop Antenna - The ultimate in a rugged antenna for the handie-talkie radio.

(5) Limp Wire Antenna - Made from special flexible, stranded and insulated wire. This antenna is useful where other more rigid antenna styles may prove hazardous to the user as they may hook or snag on some object. As with the rigid loop antenna, operative range with the limp wire antenna is less than optimum.

Antenna impedance for the HT220 and HT100 is approximately 75 ohms, not the more commonly used 50 ohm impedance. The reason for the use of 75 ohms rather than 50 ohms is the radio itself. The size of the unit and small amount of metal used in its construction necessitates the use of a slightly higher antenna impedance.

Since standard test equipment such as signal generators and wattmeters are designed for 50 ohm use, it becomes evident that steps must be taken to provide a proper impedance match for bench servicing. The NKD6001A Tune-Up-Cable provides such a match. This cable must be used with HT220 and HT100 series radios for service measurements with 50 ohm test equipment, otherwise problems such as reduction in radiated power or erroneous sensitivity measurements will result.

b. Antenna Input Circuit

Capacitors C1 & C2, coil L1 and diode CR1 form the receiver input circuit.

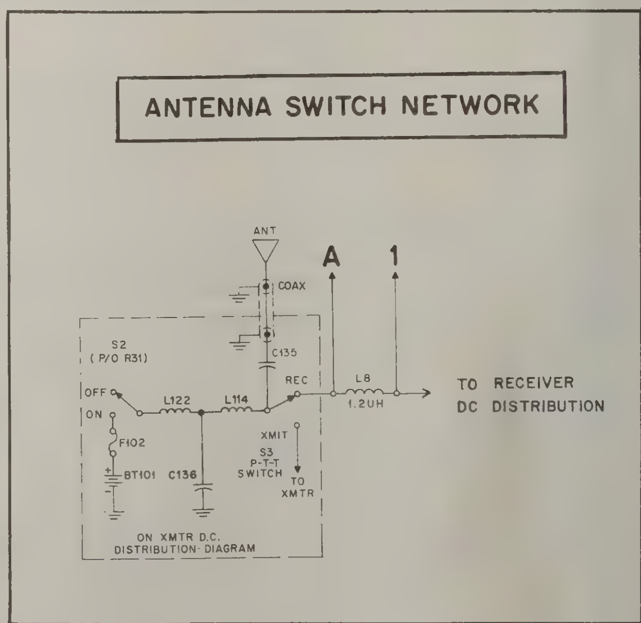


Figure 7.

The components form a parallel resonant tank circuit which will be tuned to the recei-

ver input frequency by adjusting the slug in coil L1. The series capacitors C1 & C2 resonate with coil L1 and also match the 75 ohm antenna impedance at the input tap between C1 & C2. Coil L1 is also tapped down to match the input impedance of the RF Amplifier, Q1.

Diode CR1 provides signal overload protection for RF amplifier transistor, Q1. Normally, CR1 is not conducting and therefore it is a very high impedance having little effect on the circuit. However, when a signal is applied to the antenna with sufficient voltage or strength to damage Q1, CR1 will conduct and will become a very low impeddance. Thus, detuning the tuned circuit and shunting most of the signal to ground. The diode CR1 returns to its normal non-conducting state when the input signal drops to a level where protection is no longer necessary.

3. RF Amplifier, Q1

The RF amplifier stage, and its input and output tuned circuits, fulfill two basic needs. First, the circuit provides enough selectivity to minimize intermodulation and desensitization problems. Second, the circuit amplifies the incoming signal sufficiently to help produce a good overall signal to noise ratio.

RF âmplifier, Q1, is a silicon NPN transistor used in a straightforward common-emitter configuration.

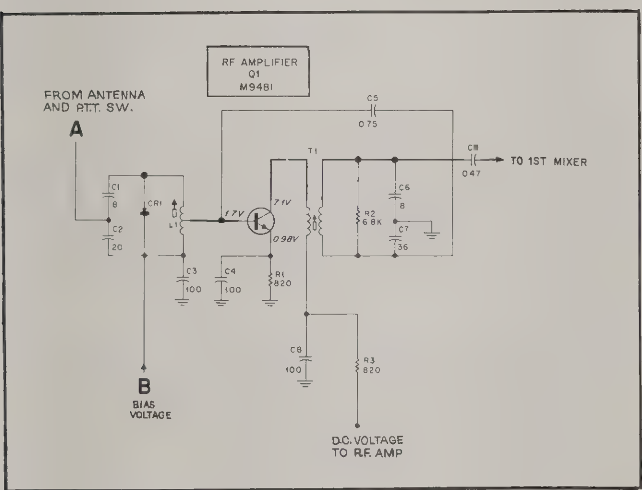


Figure 8.

4. 1st Mixer

A mixer is a non-linear device and the output signals would be the carrier frequency, the injection frequency from the oscillator, the combination of the two frequencies and also the difference frequency which is fed through three tuned tank circuits and then applied to the second mixer stage.

The collector tank circuit in the mixer stage, consisting of L4 and C20, is tuned to select the difference frequency of the mixer transistor.

This resonant circuit along with two (2) more resonant circuits in the output of the 1st mixer provide selectivity at the 1st intermediate frequency. Signals from the last resonant circuit are coupled to the base of the second mixer, Q5.

Meter position M2 is located in the base circuit of the 1st mixer stage. Meter position 1 is used to check the 1st oscillator injection voltage. The 1st oscillator injection voltage at M1 is approximately .025v RF measured with the Motorola DC Multimeter with RF probe.

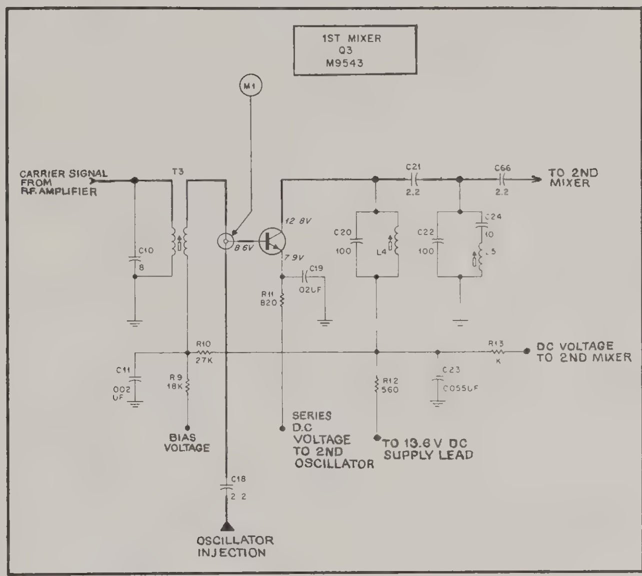


Figure 9.

5. First Oscillator

The overtone type oscillator is used as an oscillator in receivers, converters, frequency synthesizers, and test equipment. Its use is restricted to the high-frequency ranges (above 20 MC) where fundamental mode crystal operation is not practical.

Characteristics of this type of oscillator are:

a. It uses the piezoelectric effect of a quartz crystal operating on an odd overtone to provide stable high-frequency oscillations.

b. To have at least one tuned circuit at the overtone frequency.

c. Operates class C to help produce harmonic operation.

d. Regenerative feedback is provided through

e. This type of oscillator always operates as a crystal-controlled oscillator to avoid spurious frequencies.

The first oscillator is a crystal controlled series resonant type operating on the third overtone of the crystal Y1. T2 and C17, a parallel circuit tuned to the third harmonic of the oscillator frequency. This signal is capacitively coupled to

the first mixer stager (Q3) via C18. The combination of the carrier frequency and the oscillator output signal are mixed at the base of Q3 to produce the high IF frequency.

On two frequency models switch S1 allows selection of the F1 or F2 operating frequency. Coil L2 or L301 is adjusted for proper netting (to the assigned channel frequency. See alignment procedure Figure 66.

Oscillator activity can be checked by measuring the RF voltage at the base of transistor Q2 with the Motorola DC Multimeter with RF probe. This voltage should be approximately 0.6v RF.

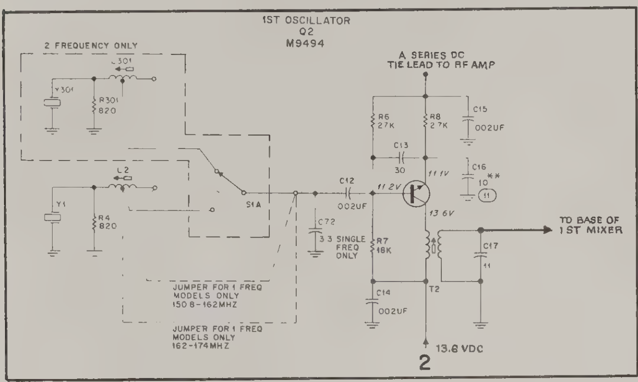


Figure 10.

6. 2nd Mixer

The first intermediate frequency signal is coupled to the 2nd mixer. In the 2nd mixer stage, the first IF signal (high IF) and the second oscillator frequency are combined or mixed to produce a difference frequency of 455 KHz at the output of the second mixer. While the second mixer stage is operating class A to minimize the generation of undesired signals, there is sufficient output at the second IF frequency, to insure sufficient coupling to the 455 KHz ceramic filter.

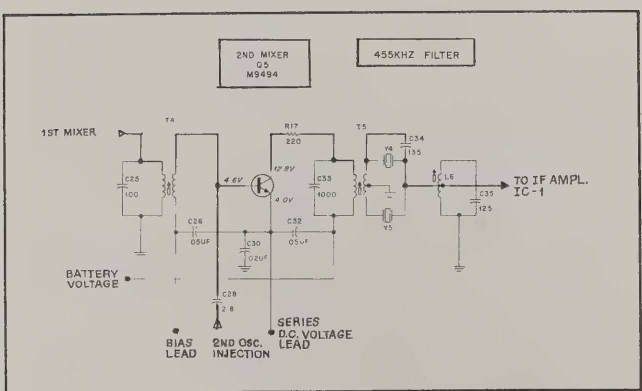


Figure 11.

7. 2nd Oscillator

To insure maximum stability, the second or low frequency oscillator is crystal controlled. The slight frequency change that occurs in this crystal controlled oscillator due to temperature has no appreciable effect on the operation of the receiver. The crystal operates as a parallel-tuned tank circuit controlling the frequency of the oscillator, with C27 providing the positive feedback necessary to sustain oscillation in this circuit.

Oscillator activity at the emitter of Q4 can be checked with a Motorola DC Multimeter with RF probe; this reading should be approximately 0.8 volts RF when the oscillator is functioning properly. Also refer to Servicing Hints section.

The 2nd oscillator frequency is not adjustable. The output from the emitter of Q4 is applied to the base of second mixer transistor Q5 along with the high IF frequency.

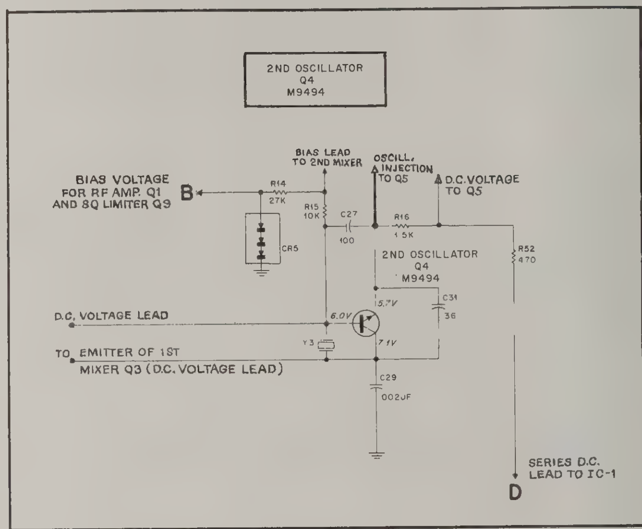


Figure 12.

8. 455 KHz Filter

A lattice type 455 KHz ceramic filter is between the output of second mixer stage Q5 and the input to the 455 KHz IF amplifier IC stage. This filter has a bandwidth of approximately 12 KHz and determines the adjacent channel selectivity of the receiver.

The second IF signal is coupled to the filter from the second mixer and is reduced to a low voltage by transformer T5. The signal then passes through resonators Y4 and Y5 to transformer L6 which increases the signal voltage. Transformers T5 and L8 are both resonant at 455 KHz.

When the second IF signal is exactly 455 KHz, both Y4 and Y5 couple the same amount of signal to the output. When the signal is at the resonant frequency of a resonator (Y4 = 452 KHz; Y5 = 458 KHz) most of the signal is coupled to the output by that resonator and very little passes through the other resonator. Signals within approximately ±3 KHz of the resonator frequency will easily pass through the filter.

Signals that are not close to 455 KHz or the frequencies of the resonators will be greatly attenuated. These signals are reflected by the selectivity of tuned transformers T5 and L6 and by

the balancing action of a bridge network (secondary of transformer T5 and resonators Y4 and Y5). The points of maximum rejection, at which the bridge balances, are controlled by capacitor C34.

The components of this filter are not encapsulated but are mounted individually on the printed circuit board. The filter is, therefore, serviceable since parts may be removed and replaced as necessary.

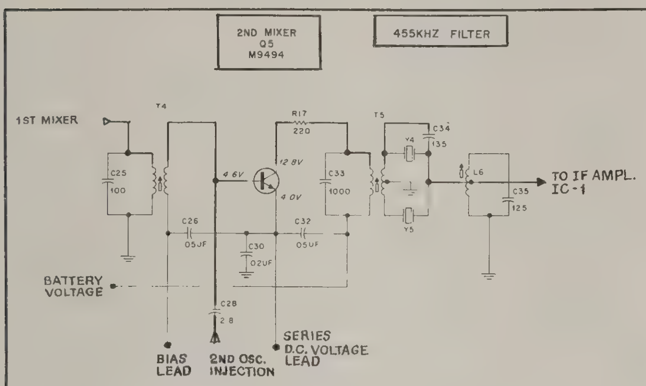


Figure 13.

9. Operational Amplifiers (Integrated Circuit)

The operational amplifier has recently become one of the most versatile tools in electronics. It can be used wherever varying signals are processed, for example, in audio amplifiers, oscillators, power supplies and IF amplifiers. It can take the place of a large number of individual transistors, resistors and capacitors for many applications.

The passive components used with the operational amplifier primarily determine circuit performance.

Operational characteristics are generally exceptionally high gain and wide bandwidth. The external components can control gain, frequency response and impedance.

The particular IC (Integrated Circuit) that is used in this radio is an SC1482, and the IC is used as the complete 455 KHz IF amplifier section. It

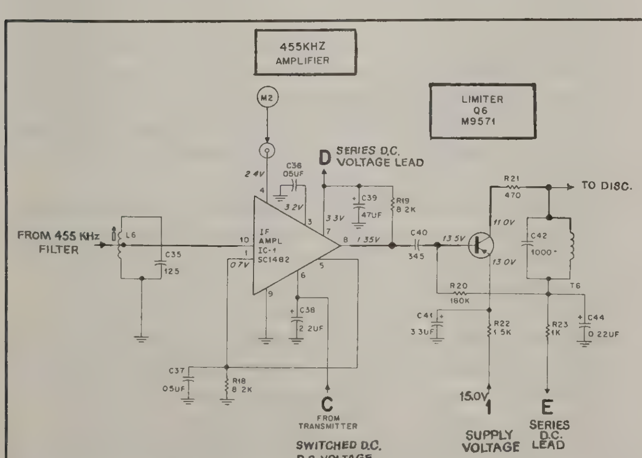


Figure 14.

provides a connection for external metering, (meter position M2) which is an internal check of the gain of the 455 KHz IC. It provides more than an ample amount of gain for this section of the receiver, and the output of the 455 KHz IC is sufficient to drive the Limiter stage (Q6) into full limiting.

10. Limiter

The function of the limiter is to remove amplitude variations in the signal. Since the limiters pass frequency deviations, no distortion results.

For complete limiter action, the input signal must be strong enough to be limited. This means that RF and IF amplification must build up the signal sufficiently to make limiter action possible.

The undesirable variations in the amplitude of the FM signal are caused by natural and man-made noises, static disturbances, and fading of the received signal. Still other amplitude variations are introduced within the receiver itself.

The purpose of the limiter is to remove these undesirable variations to allow the discriminator circuit to detect a change in frequency and prevent it from reacting to a change in amplitude.

The low IF frequency (455 KHz) after being amplified by IC-1, is coupled to the limiter (Q6) where any amplitude modulation of the signal is removed. The limited signal is then fed to the discriminator stage where this signal is translated into an audio signal.

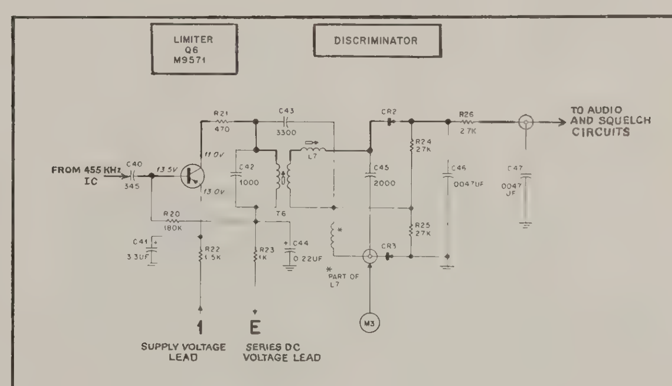


Figure 15.

11. Discriminator

All FM receivers incorporate some circuit device to convert the incoming frequency deviations of the IF signal, which contains the intelligence.

It converts frequency variations, the audio message, into voltage variations which are applied to audio amplifier circuits for further voltage and power amplification. The circuit used is a conventional "Foster Seeley" discriminator. The collector circuit of the limiter is tuned to the IF center frequency (455 KHz). The complete input circuit of the discriminator is tuned to the same frequency by means of coil L7.

The limited signal is fed to the discriminator diodes CR2 and CR3 where the frequency variations of the incoming signal are translated into an audio signal and this signal is then filtered and amplified further in the audio amplifier stages.

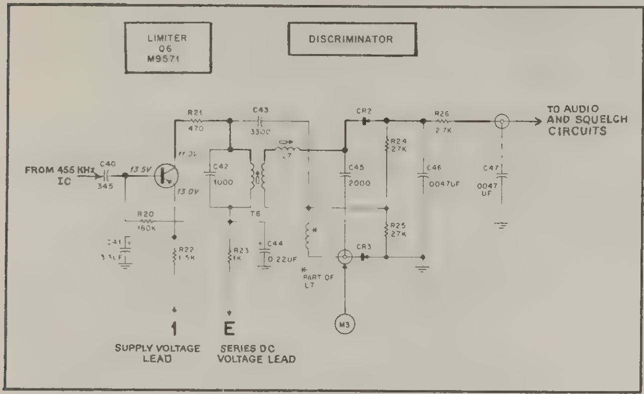


Figure 16.

12. Active Filter

The first stage in the receiver audio section is Q7 which is an active high pass filter with unity gain in the pass band. At the cut-off the filter has a gain of approximately 2 db. At lower frequencies, the roll-off is 18 db/octave. The low frequency roll-off is approximately 300 Hz. This type of filter for PL frequencies has phase shift networks consisting of R29 & C53 - R28 & C52. These phase shift networks filter out all frequencies below 300 Hz, and pass all frequencies above 300 Hz or all audio voice frequencies.

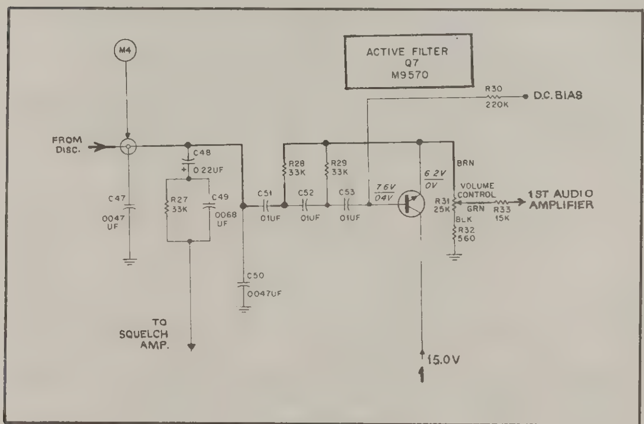


Figure 17.

13. Audio Section

a. 1st Audio Amplifier & Audio Driver

The output of the active filter is coupled to the receiver volume control. From the volume control the signal is fed to three direct-coupled audio stages.

The first audio amplifier (Q12) has a fixed bias. This voltage forward bias Q12 which allows it to amplify the audio signal applied to it. When Q12 conducts it also applies forward bias to the Audio Driver (Q14), which will allow it to amplify the audio signal and apply it to the audio final circuit, and also provide bias voltage for the final audio circuit.

b. Final Audio Amplifier

The final audio circuit is a complementary symmetry circuit, which is capable of 500 mw of audio across a 40 ohm speaker.

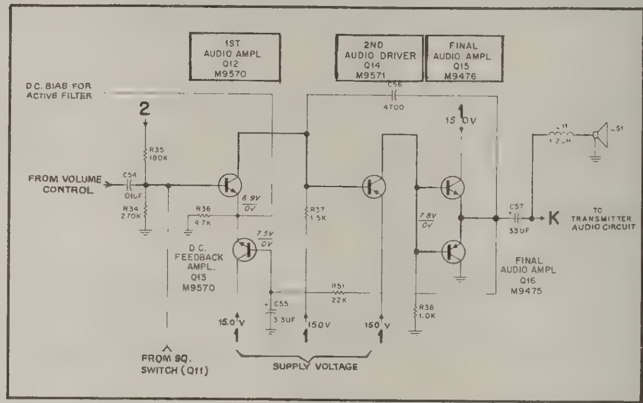


Figure 18.

14. Squelch Circuitry

Purpose

The squelch circuitry mutes the receiver during the intervals between messages, thus preventing the normal no-signal noise from being heard at the speaker. The squelch circuitry takes noise from the discriminator stage through a high-pass filter, amplifies it, and converts it to a DC voltage which generates the squelch switch stage (Q11) which turns the audio circuitry on or off.

Requirement

Squelch operation is dependent upon the presence of an adequate amount of noise at the discriminator. This noise level should be approximately -16 db at meter position M4, or approximately -34 db at the base of transistor Q8. These levels exist under no carrier conditions. There must be a large voltage change at the base of the 1st audio amplifier when the squelch control is turned from minimum to maximum squelch.

Operation of the squelch circuitry depends upon the presence of noise during the absence of a carrier signal or the absence of noise when a carrier signal is present.

Noise from the discriminator is applied to the noise amplifier (Q8), where the very low level noise is amplified, then coupled through the squelch control. The noise signal is the capacitively coupled to the squelch limiter (Q9) stage, which is followed by a noise detector and a squelch switch.

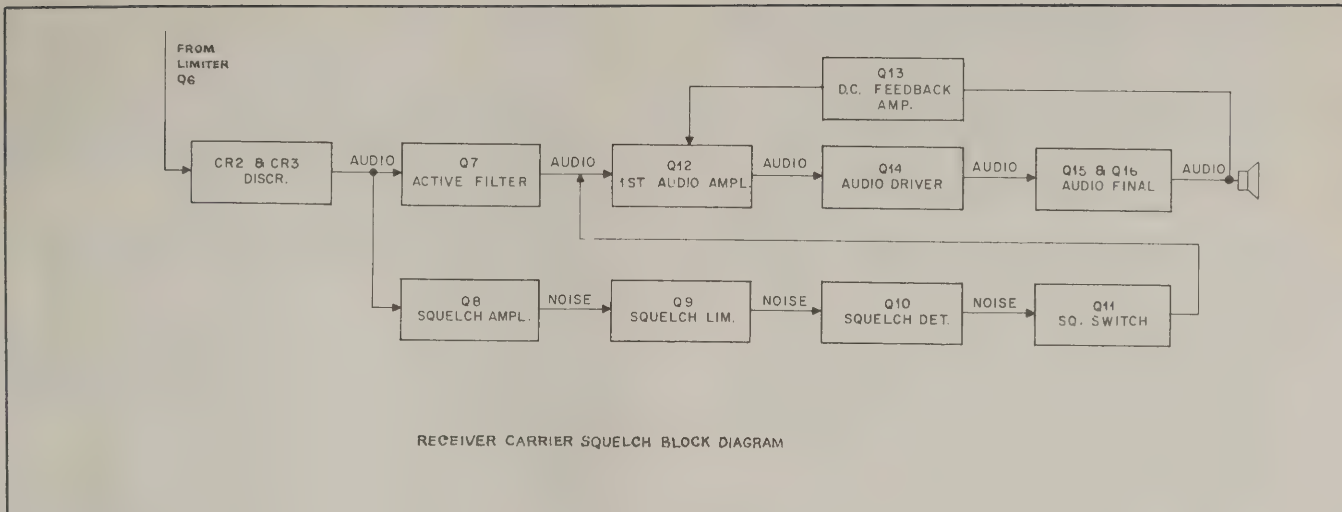


Figure 19 and Figure 20.

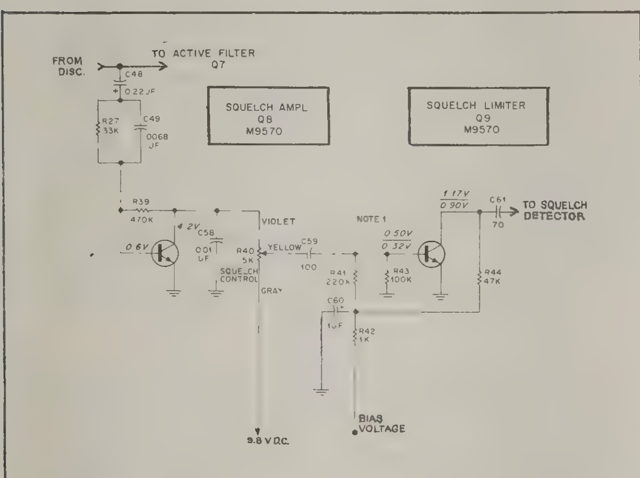


Figure 21.

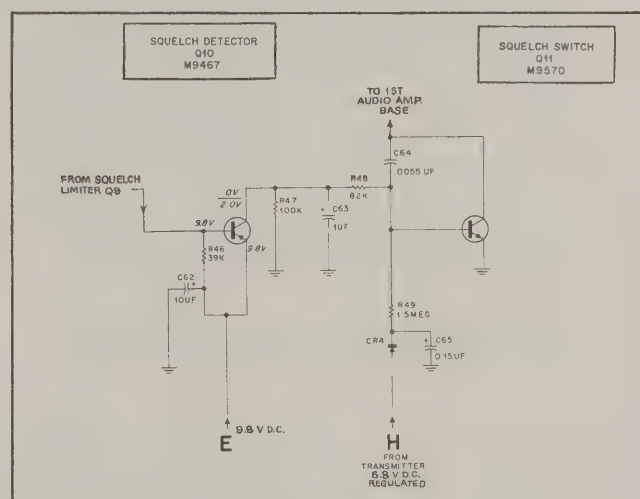


Figure 22.

The signal applied to the squelch limiter stage is of sufficient magnitude to drive the limiter into full limiting. The output of the limiter is capacitively coupled to the squelch detector which controls the operation of the squelch switch.

The squelch detector converts noise pulses to a rectified signal which is filtered by C63, to produce a DC voltage which controls the ON and OFF condition of the squelch switch. When a high level of noise is present in the squelch circuitry, the DC voltage at the collector of squelch detector Q10 goes positive to +2.0v DC. During an absence of noise and during a carrier signal, the DC voltage drops to zero.

When the receiver senses an on-channel signal, the noise decreases, thus reducing the DC voltage at the squelch switch stage (Q11 base) input which in turn opens the switch and turns on the audio stages.

When the receiver is squelched, the squelch switch Q11 saturates and grounds the base of audio amplifier Q12. This disables the 1st audio amplifier. Which in turn disables the audio driver Q14 and puts the base voltage of the symmetrical audio output stage Q15 and Q16 at zero. This action also sets the emitters of Q15 and Q16 at zero volts which back biases the DC feedback amplifier Q13 cutting it off. Thus, when the receiver is in the squelch mode, all of the transistors in the audio section are turned off.

15. Receiver DC Distribution

The DC distribution block diagram has several letters and numbers to identify different DC distribution tie points and does not identify a specific DC level.

A technique used in limiting total current drain in the receiver is to connect several stages in series DC wise, such as the limiter stage in series with some of the squelch circuits, and the RF amplifier in series with the 1st oscillator.

The diagram also indicates the DC voltage being switched between the receiver and transmitter,

with chokes being used to filter the RF signal out of the DC voltage, and capacitors to block DC voltages from the signal path.

The one unique component in this diagram is CR5, which is a 2 volt stacked diode.

CR5 is used to develop a regulated bias voltage for several different circuits in the receiver.

C. TRANSMITTER DETAILED CIRCUIT ANALYSIS

1. Transmitter General Description

This series of "Handie-Talkie" FM Radio Sets is a completely solid state, crystal controlled unit with an integrated circuit for the audio section. It also uses a combination speaker-microphone.

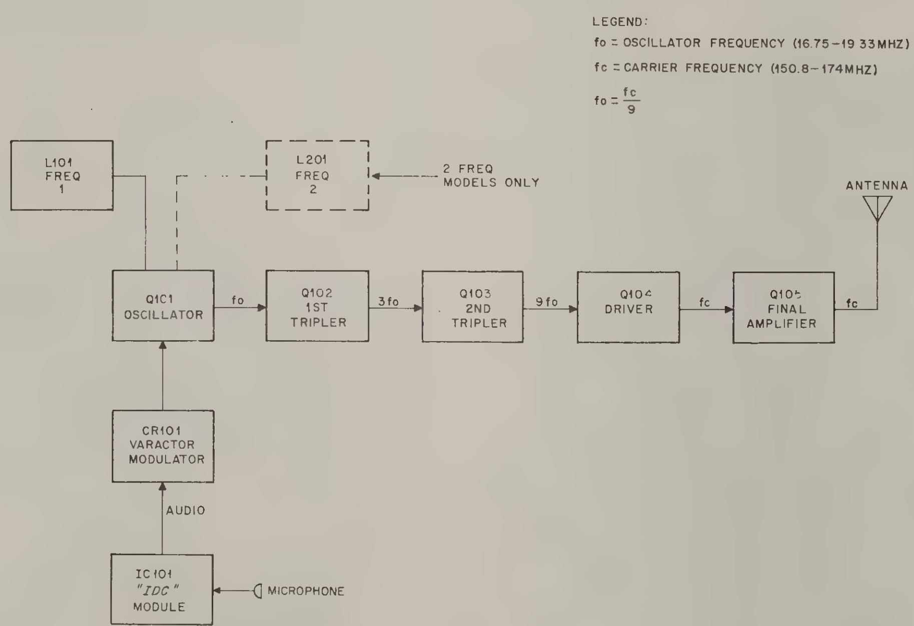
The audio section of the transmitter consists of a speaker-microphone which produces a low level audio output that is coupled into an integrated circuit module (IC101). This module provides amplification, clipping, and audio shaping. The output of the IC module is coupled through the IDC (instantaneous deviation control R119) and capacitively coupled to the oscillator/modulator stage.

The RF section consists of a crystal controlled series resonant circuit, with varactor CR101 in series with the frequency control crystal Y101. Coil L101 permits an adjustment of the transmitter operating frequency.

Modulation of the transmitter is accomplished by direct frequency modulation of the carrier frequency.

The output signal from the oscillator is fed into frequency multiplier stages Q102 and Q103 where it is multiplied nine (9) times to produce the desired carrier frequency.

After the oscillator signal has been multiplied up to produce the proper carrier frequency, this RF signal is applied to the driver amplifier. This stage provides the proper RF power to drive final amplifier Q105. The signal is amplified again in the final stage, then coupled through the harmonic filter and antenna matching network to the antenna. This would be the transmitter rated RF output signal.



Transmitter Block Diagram

Figure 23.

2. Audio Circuits

The speaker-microphone produces a low level audio output which is capacitively coupled to the input of the integrated circuit module IC101. This module provides the functions of amplification, clipping, and audio shaping. The Instantaneous Deviation Control (IDC) circuitry is included in the module. The audio signal appearing at the output of IC101 has been amplified, pre-emphasized from 300 - 3000 Hz at a 6db/octave rate, and attenuated if its frequency is above 3000 Hz.

The audio "splatter" filter, consisting of L113, R117, and C132, provides attenuation of all audio frequencies above 3000 Hz. The audio signal from the integrated module IC101 is capacitively coupled to the oscillator/modulator stage.

3. Oscillator/Modulator

Oscillator stage Q101 is a crystal controlled series resonant circuit, with varactor CR101 in series with the frequency control crystal Y101. The frequency adjustment (warping) coil L101, which permits setting of the operating frequency, is also in series with the crystal. On two frequency models there is another coil, L201, which, in conjunction with crystal Y201, provides the frequency determining components for the second oscillator frequency. Switch S2 is used to switch the F1 and F2 operating frequencies, allowing transistor Q101 to serve as the oscillator for both F1 and F2 frequencies.

Modulation of the transmitter is accomplished by applying the audio output from the integrated circuit module IC101 to the varactor CR101 in the oscillator circuit. The audio signal at the varactor varies the capacitance of the varactor which, in turn, results in a frequency shift in the oscillator's frequency, at an audio rate. Direct frequency modulation of the carrier frequency is produced by the action of the varactor.

4. Multiplier Stages

The output signal from oscillator Q101 is fed into the frequency multiplier stages Q102 and Q103 where it is multiplied 9 times to produce the desired carrier frequency. Without an input signal, a zero-biased class B frequency multiplier stage will not draw any emitter current. With drive present, the transistor draws current, which is monitored by measuring the DC voltage developed across the Q102 first tripler collector resistor R106 (metering point M11). (Refer to the transmitter alignment procedure). The second tripler stage Q103 likewise may be monitored by measuring the voltage developed across the second tripler emitter resistor R108 (metering point M12). Since the signal input level to the first tripler is very low, a small amount of forward bias is supplied to increase the gain of the stage.

5. Driver and Final Amplifier

After being multiplied, the RF signal is applied to the driver amplifier Q104. This stage provides the proper RF power to drive the final amplified Q105 to the rated power output level. The circuit between the collector of Q105 and the antenna provides attenuation of carrier frequency harmonics and also functions as a load matching network to insure maximum transfer of RF to the antenna.

When tuning the radio, adapter cable NKD6001A must be used when aligning the transmitter into a 50 ohm wattmeter in order to simulate the actual impedance of the antenna. If tune-up cable NKD6001A is not used, reduced radiated power will result if tuned directly into the wattmeter.

The tuned circuits at the input and output of the final amplifier Q105 are tuned for best power output and minimum current drain. (Refer to transmitter alignment procedure).

6. Transmitter DC Distribution

All of the circuits are in parallel in the transmitter DC voltage circuit.

The DC voltage and RF signal are switched between the receiver and transmitter with the same set of contacts on the Push-to-talk switch.

Capacitor C135 blocks DC voltage from the antenna and RF chokes L122, L114 and L115 filter RF frequencies from the DC voltage string.

All of the DC voltage tie points are identified by a letter symbol and do not indicate an actual DC voltage level.

7. Receiver Mute Function

The purpose of the muting function is to squelch or shut off the receiver audio circuitry while transmitting to prevent a noise burst in the speaker at the end of the transmission.

This is accomplished with the connection of tie point "H" in the transmitter which is 6.8v DC regulated, to tie point "H" in the base circuit of the squelch switch transistor (Q11) in the receiver.

When the push-to-talk switch is depressed it removes the DC voltage from the receiver and connects it to the transmitter through the contacts of the switch. Because the voltage is removed from the receiver during transmit, as soon as the voltage is switched back to the receiver at the end of each transmission, the noise in the receiver is gradually building back up and there isn't enough noise to actuate the squelch circuitry properly. This would cause this low level noise to be heard in the speaker.

To eliminate this noise burst at the end of each transmission a positive DC voltage is applied to the anode of CR4 forward biasing it and charging C65, also forward biasing the squelch switch (Q11) stage during transmit.

At the end of each transmission the positive vol-

tage is removed from the anode of CR4 reverse biasing the diode. At this same instant, the voltage is reapplied to the receiver and C65 starts discharging, which continues to keep Q11 conducting. This causes the 1st audio amplifier to be reversed biased, squelching the audio stages in the receiver.

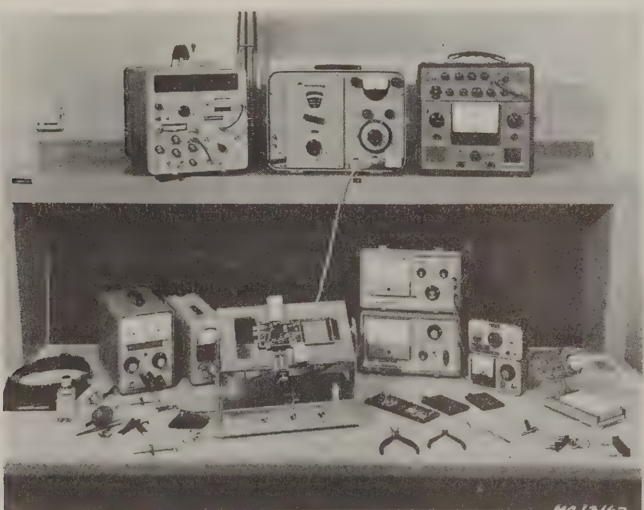
The noise in the receiver gradually increases to a level where the squelch circuitry takes control of the squelch action in the receiver. At this time the DC input from the transmitter (tie point "H") no longer has any effect on the squelch switch stage.

IV. SERVICING THE HT 'HANDIE- TALKIE' FM RADIO

A. INTRODUCTION

This section will be devoted to testing and servicing procedures used on the "Handie-Talkie FM Radio". The information herein covers the HT220, single and dual frequency carrier squelch models, and tone coded squelch models (PL). Also covered is the HT100 unit with single and dual frequency carrier squelch, and the HT100 Tone Coded squelch models.

Servicing the "Handie-Talkie FM Radio" will require localizing a malfunction before the defective component can be located and replaced. Since components are not easily removed, localizing is a very important part of servicing. Therefore, a thorough understanding of the circuits will aid the technician in performing efficient servicing of this HT.



A COMPLETE SERVICING BENCH SETUP

Figure 24.

A serviceman must know how one function effects another as well as the overall operation of the radio and what procedures are necessary to place the unit back in operation in the fastest possible time. Information such as Stage Gain Measurements, Scope Waveforms and DC Voltages are presented in the following section. Readings will be average readings and in actual practice will vary slightly. However, following the outlined procedures will aid the technician in servicing the unit.

Due to the advent of IC's (Integrated Circuits) and the use of a double-sided printed circuit board with plated through eyelets, special servicing techniques must be used. This section gives special procedures to aid in speedy localization of malfunctions, gives procedures for easiest replacement of components, and emphasizes special service hints and precautions.

Therefore, to aid in attaining proficiency the serviceman should become familiar with the information presented in this section.

Effective servicing must include understanding all of the circuits in the entire radio. It must include proper techniques of localizing a malfunction as well as the techniques in replacement of components, including the use of proper tools.

B. RECOMMENDED TOOLS LIST

1.	ST572	Solvent	Included in TEK-4A Kit (items 1–8)
2.	ST493	Brush	
3.	ST472	40 watt Solder Iron	
4.	ST481	Tip (40 watt)	
5.	ST494	Straight Pick	
6.	ST496	Bent Pick	
7.	ST492	Tweezers	
8.	ST725	Solder Sucker	
9.	66-83117C01	Seizures	
10.	ST200	Side Cutters	
11.	ST201	Long Nose Pliers	
12.	ST562	Wire Strippers	
13.	ST815	20 watt Solder Iron	
14.	ST816	Solder Iron Holder	
15.	ST863	Hooked Pick	
16.	ST864	Finger Pick	
17.	ST865	Cutters	
18.	ST866	Curved Long Nose Pliers	
19.	ST867	Pointed Side Cutters	
20.	ST260	Allen Wrench Set	
21.	NLN6689A	Tuning Tools	
22.	66P84301A18	IC Desoldering Tip for 40 watt Iron	

C. TEST EQUIPMENT

All the required test equipment needed for aligning and testing the "Handie-Talkie" Radio Set described in this manual is listed in the following Test Equipment Chart. The listed items or their equivalents may be used.

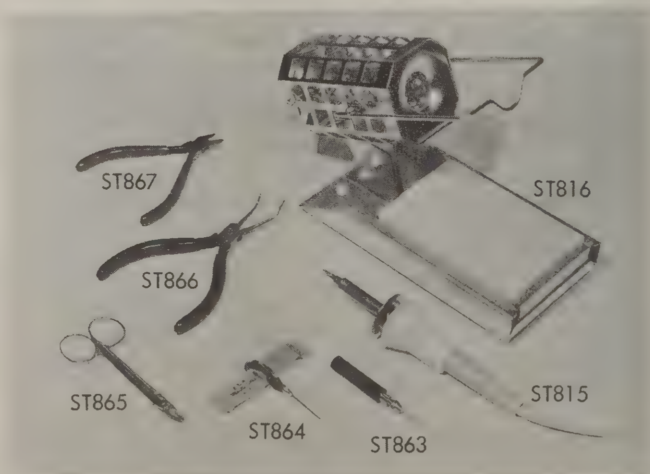


Figure 25.

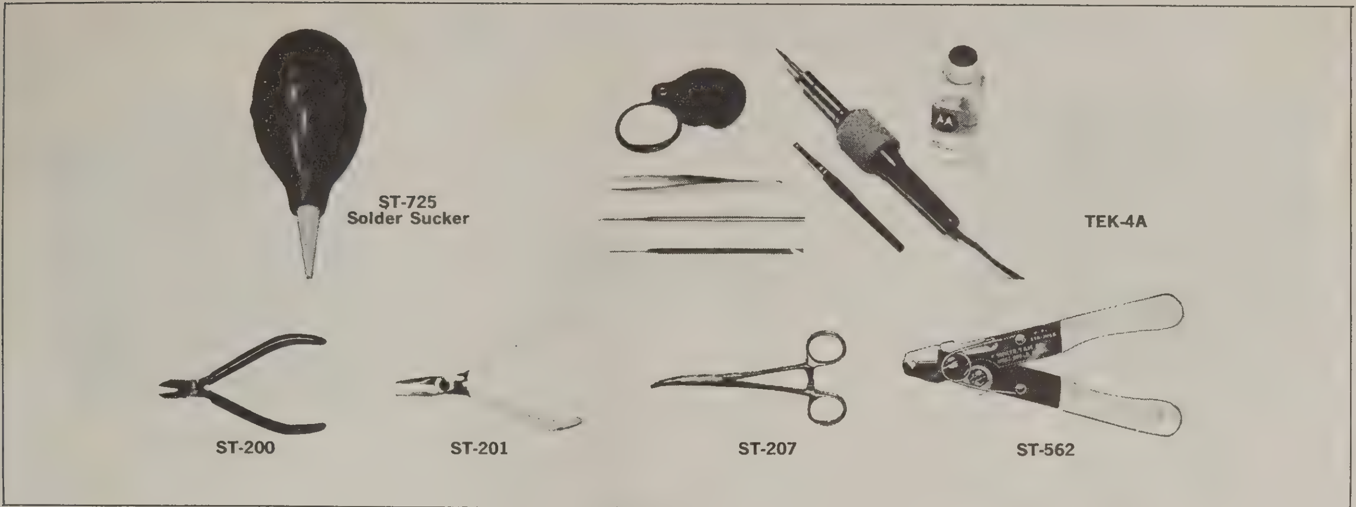


Figure 26.

TEST EQUIPMENT CHART

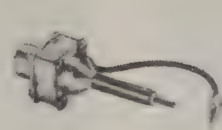
EQUIPMENT	PURPOSE
Motorola DC Multimeter with rf probe.	All dc and rf measurements. Monitoring input current when external power supply is used.
Motorola AC Voltmeter S1051-C.	All ac signal measurements.
Oscilloscope - Motorola T1015A General Purpose or S1301 Precision Wide-Band	IDC Adjustment.
455 KHz Crystal-Controlled Oscillator - Motorola S1056A-9A Series Test Set with 455 KHz crystal.	Alignment of 455 KHz i-f filter, limiter, and discriminator stages.
RF Wattmeter, 50 ohms impedance.	RF Output power measurements.
DC power supply capable of supplying 15 vdc at 1 ampere. Motorola TEK-23.	Supplying dc power to the unit during extended servicing.
Motorola TEK-10RF injection probe.	Stage gain measurements.
Motorola NEN6072A Test Jig with NKD6001A Tune-up Cable.	To hold the radio set for alignment or testing, keeping the push-to-talk button depressed, applying external power.
Motorola NLN6689A Alignment Tool (supplied with the radio set).	Adjusting the tuning coil slugs.
Motorola T1034B Signal Generator	Generating frequencies.
Motorola S1078A Digital Frequency and Deviation Meter.	Checking frequencies and deviation.
Motorola TEK-1A Solid-State Tone Generator.	1000 Hz test tone frequency.

NOTE:

The NKD6001A Tune-up cable <u>must</u> be used when aligning a transmitter into a <u>50 ohm</u> wattmeter in order to simulate the actual impedance of the antenna. Reduced radiated power will result if the radio is tuned directly into the wattmeter without the tune-up cable.

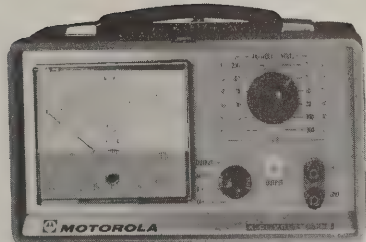
RECOMMENDED TEST EQUIPMENT

S1056A-S1059A
TEST SET

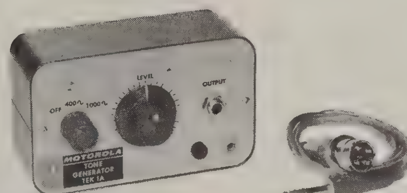


TEK-10 RF Cable Adapter

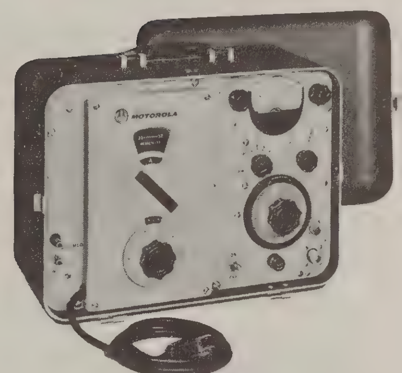
DC MULTIMETER



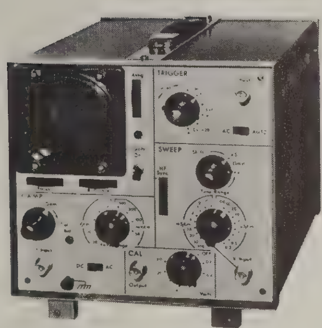
S1051-C
TRANSISTORIZED AC
VOLTMETER



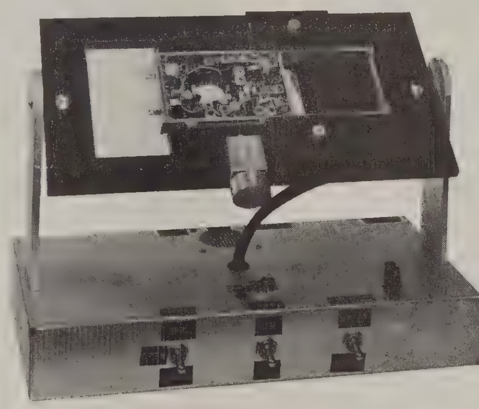
TEK-1A
TRANSISTORIZED TONE
GENERATOR



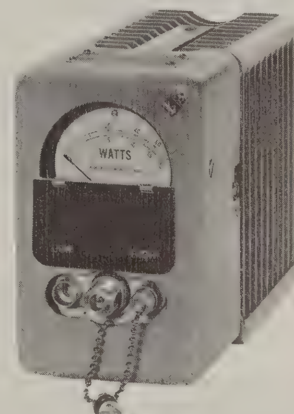
T1034C
SIGNAL GENERATOR



S1301
PRECISION WIDE BAND
OSCILLOSCOPE



NEN6072A
TEST FIXTURE



MODEL 61
RF WATTMETER

TEK-23
POWER SUPPLY

S1078B DIGITAL
FREQUENCY METER

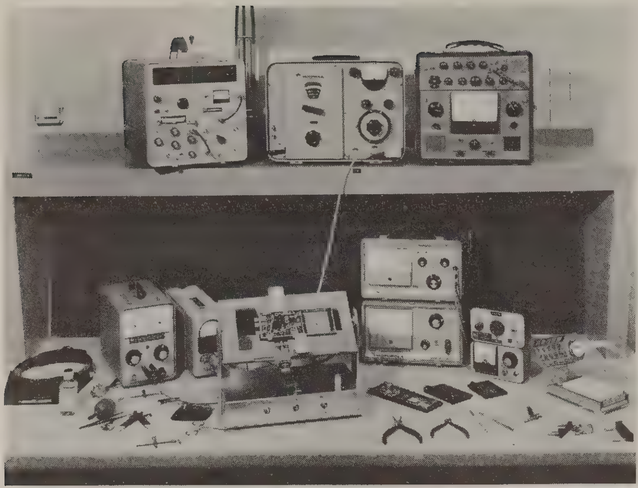


Figure 27.

D. SPECIAL TEST EQUIPMENT OPERATION

1. Use of the Test Fixture

The Motorola NEN6072A Test Fixture holds the H23FFN and H13FFN series of FM Radio Sets while testing or aligning the transmitter or receiver. Referring to the disassembly procedure, the battery cover, and back cover are removed from the radio before the radio is placed in the test fixture. The radio can also be mounted in the test fixture with or without the battery and with or without the front cover. The radio is placed in the test fixture with the soldered side making contact with the metering pins on the test fixture as shown in photograph on page .

a. The holding brackets are pushed against the radio set to hold it in the fixture.

b. The two sliding guides are used to line up the HT220, HT100 and the HT220 with extended housing.

c. The large knob is turned in either direction to engage its plunger against the push-to-talk switch of the radio set, in order to transmit.

A Motorola TEK-23 power supply, or equivalent, is connected to the test fixture to provide power while testing or aligning the radio. The power is connected to the "pwr" terminals on the back of the test fixture. An Audio Oscillator (S1067A) is connected to the test fixture to provide the 1000 Hz AC signal used to check transmitter audio deviation. The oscillator is connected to the "Osc" terminals on the back of the test fixture. A Motorola S1051C AC Voltmeter is used to measure the AC voltage developed at the output of the receiver and to measure AC voltages at meter position M2 in the receiver. The AC Voltmeter is also used to measure the level of AC that is coupled into the transmitter when setting transmitter audio deviation and when checking the sensitivity of the transmitter IDC circuitry. The AC Meter is connected to the AC VTVM terminals on the back of the test fixture.

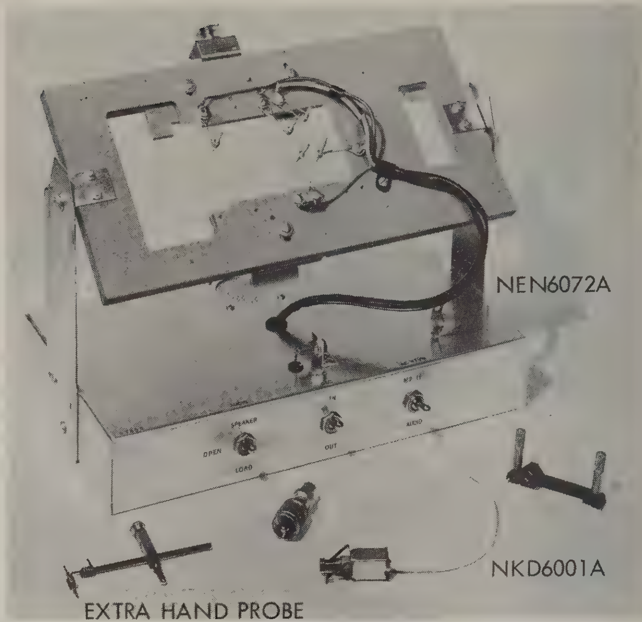


Figure 28.

2. Text Fixture Switches

a. Speaker Switch

This switch is a three position switch. The load position connects a 40 ohm resistor across the audio output circuit so the service technician doesn't have to listen to the noise at the speaker during servicing. With the switch in the open position, it will allow the radio to be serviced with its own internal speaker. And with the switch in the speaker position it will connect the 40 ohm speaker in the test fixture which will allow the service technician to listen to the audio output of the receiver.

b. Oscillator Switch

This switch is a two position switch which connects the Audio oscillator signal across the "Speaker-Microphone" terminals. With the switch in the "IN" position it allows the AC output of the audio oscillator to be measured by the AC voltmeter. This is also the AC signal which is applied to the audio circuit of the transmitter when setting transmitter audio deviation. With the switch in the "OUT" position the audio oscillator is disconnected from the radio and the AC voltmeter.

c. AC VTVM Switch, a 2 position Switch

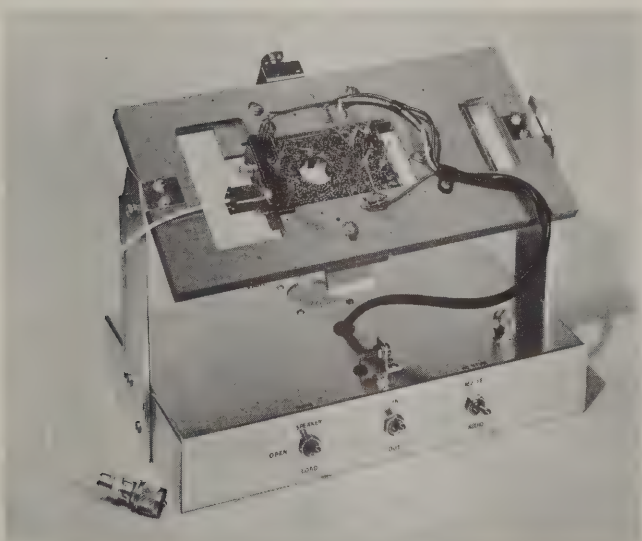
The switch connects the AC Voltmeter to the audio output or to metering point M2, which will allow one position or the other to be monitored. M2 position will connect meter position M2 in the receiver to the AC VTVM. When monitoring in this position allows the technician to tune up the complete front end of the receiver except for the oscillator coil adjustment. The M2 10 db rise check could also be made at

this time. Audio position connects the audio output of the receiver to the AC VTVM. This will permit the technician to make a 20 db quieting measurement with the AC VTVM permanently connected for quicker and easier test measurements.

3. Adapter Cable NKD6001A

The NKD6001A tune-up cable must be used when aligning the transmitter into a 50 ohm wattmeter in order to simulate the actual impedance of the antenna. Reduced radiated power will result if the radio is tuned directly into the wattmeter without the tune-up cable.

The antenna impedance of the HT220 and HT100 is approximately 75 ohms, not the more commonly used 50 ohms impedance. The reason for the use of 75 ohms rather than 50 ohms is the radio itself. The size of the unit and small amount of metal used in its construction necessitates the use of a slightly higher antenna impedance.



HT220 MOUNTED IN TEST FIXTURE NEN6072A, WITH ADAPTER CABLE NKD6001A.

Figure 29.

Since standard test equipment such as signal generators and wattmeters are designed for 50 ohms use, it becomes evident that steps must be taken to provide a proper impedance match for bench servicing. The NKD6001A tune-up cable provides such a match. This cable must be used with HT220 and HT100 series radios for service measurements with 50 ohm test equipment, otherwise problems such as reduction in radiated power or erroneous sensitivity measurements will result.

E. "HANDIE-TALKIE" SERVICING PROCEDURES

1. Introduction

There is a need for the service technician to perform a quick operational check of the receiver and transmitter. The need arises from the customer complaint: does the user really have a problem with the radio?

The user of this radio is not electronically inclined nor does he know all of the terms used in explaining a problem.

The radio may work intermittantly. It is also possible that the radio may only have problems with the cover on.

This is why a technician's first step is to determine what is the problem with the radio. Is it in the transmitter or receiver, is it the battery, or could it be something external of the housing?

A list of some of the preliminary checks are outlined below.

a. Receiver

(1) Turn the unit on and check for noise at the speaker.

(2) Check 20 db quieting by ear.

(3) Check carrier squelch sensitivity by listening.

b. Transmitter

(1) Check transmitter RF by the use of a field strength meter indication.

(2) Check power output by keying the transmitter into a wattmeter.

(3) Check transmitter frequency by radiating the transmitted RF into a frequency counter.

(4) Check audio deviation by whistling into the microphone

(5) Check PL deviation with no voice modulation.

2. Receiver Performance Measurements

a. Preliminary Bench Tests

(1) Turn on the radio, unsquelch it, and check for a high level noise at the speaker. If defective, refer to the RF and Audio Stage Gain Charts.

(2) If the noise level is OK, check 20 db quieting by ear using the signal generator (T1034B). If defective, refer to the RF and Audio Stage Gain Charts and the alignment procedure.

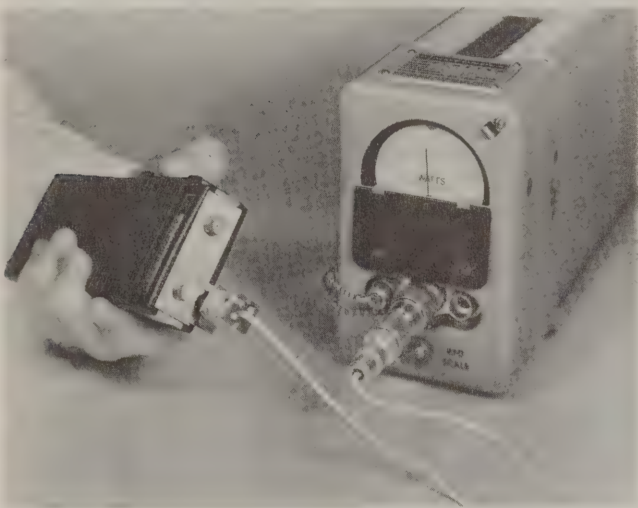
(3) If 20 db quieting checks OK, then modulate the carrier with 1,000 Hz signal with 3.3. KHz deviation and check for audio level and distortion. If defective, refer to the Audio Stage Gain Charts.

(4) If the quieting check is OK, then check

the carrier squelch operation. Check for a squelch and unsquelch condition by varying the squelch control.

(5) If the squelch action checks OK, measure the squelch sensitivity. If defective, refer to the squelch circuit AC & DC measurements charts.

(6) If the squelch sensitivity checks OK, then check the receiver PL (Private Line) sensitivity if applicable. If defective, refer to the receiver alignment procedure and the PL servicing information.



PRELIMINARY POWER OUTPUT CHECK USING ADAPTER CABLE NKD6001A.

Figure 30.

b. Detailed Receiver Measurements (using NEN6072A Test Fixture)

(1) Introduction

This section contains complete testing procedures for the receiver using the NEN6072A test fixture and NKD6001A adapter cable.

The testing procedures apply to the HT100 as well as the HT220.

Several quick measurements that can be made when using the test fixture (NEN-6072A) are listed below, along with the step-by-step testing procedure for performing these measurements.

(a) Make a 20 db quieting measurement. Refer to the alignment procedure for proper instruction.

(b) Make a 10 db rise check at meter position M2.

(c) Perform a squelch sensitivity check.

[1] Carrier squelch

[2] Tone coded squelch "PL".

(d) Perform a rated audio output test.

(e) Check discriminator zero, "M4".

(f) Check receiver frequency.

(2) 20 db Quieting Sensitivity Check

A good overall check of the receiver operation is the 20 db quieting sensitivity measurement. This check will indicate that the receiver has sufficient gain and that all the included circuitry is working properly. The quieting signal is that RF signal input necessary to reduce the audio output at the speaker by 20 decibels. The measurement should be made in the absence of extraneous signals. Since the receiver squelch circuitry reduces the noise at the speaker, the squelch control should be set for maximum noise while making this measurement.

The actual measurement is made by observing the noise voltage at the speaker on an AC voltmeter with no RF signal received at the antenna. Sufficient carrier signal from a recommended signal generator is then introduced via the antenna opening, using the NKD6001A, to reduce the noise output voltage to 1/10 of the previous reading. If all circuitry is operating properly, the quieting signal should be 0.35 microvolt or less.

STEP-BY-STEP PROCEDURE FOR A 20 DB QUIETING CHECK

(a) With the radio mounted in the test fixture, 15.0V DC supply voltage connected to the unit, turn the ON-OFF switch Volume control to the ON position, turn the Squelch control to minimum squelch (fully counter-clockwise).

(b) Connect the RF adapter cable model NKD6001A to the antenna connector on the HT.

(c) Connect the signal generator model T1034C to the adapter cable and adjust the signal generator frequency dial to the operating frequency of the HT receiver. This is accomplished by monitoring the DC voltage at meter position M4, and adjusting the signal generator for a zero volt reading at this point. This would indicate that the generator is on center frequency (or carrier/operating frequency).

(d) Test Fixture Settings

[1] <u>Audio Switch.</u>

a In speaker or load position when servicing the receiver with its own internal speaker removed.

[2] Osc. Switch. Place the Osc. IN-OUT switch in the OUT position.

[3] AC VTVM Switch. Place this switch in the Audio position.

(e) Adjust the signal generator for minimum output.

(f) Adjust the volume control on the radio for a +10 db (2.5V AC) on the AC Voltmeter.

(g) Now increase the output signal of the signal generator until the AC voltmeter reading decreases by 20 db, or a reading of -10 db.

The amount of signal required to do this should be less than .35 uv.

This completes the 20 db quieting measurement.

(3) 10 db Rise Check

WATCH

(a) Introduction

The reason for making a 10 db rise check at "M2" metering point is to check the gain of the front 1/2 (RF, IF, 1st, and 2nd oscillators, 1st and 2nd mixers and 455 KHz Filter) of the receiver. This check also isolates a problem is the receiver. Is the problem in the front 1/2 or the back half (Limiter, Discriminator, Audio Stages and Squelch circuits) of the receiver?

Once this is determined, you can then refer to the appropriate servicing section or stage gain procedure.

(b) Measurement Procedure

[1] Mount the radio in the test fixture, and connect 15.0V DC supply voltage to the unit and turn the ON-OFF switch volume control to the On position.

[2] Connect the RF adapter cable model NKD6001A to the antenna connector on the HT.

[3] Connect the signal generator to the adapter cable and adjust the signal generator for the operating frequency of the HT receiver.

[4] Test fixture settings.

a "Speaker Int. - Speaker-Load" switch in the "load" position.

b The "Audio-AC" switch in the AC position.

c The "Audio-M2" switch in the M2 position.

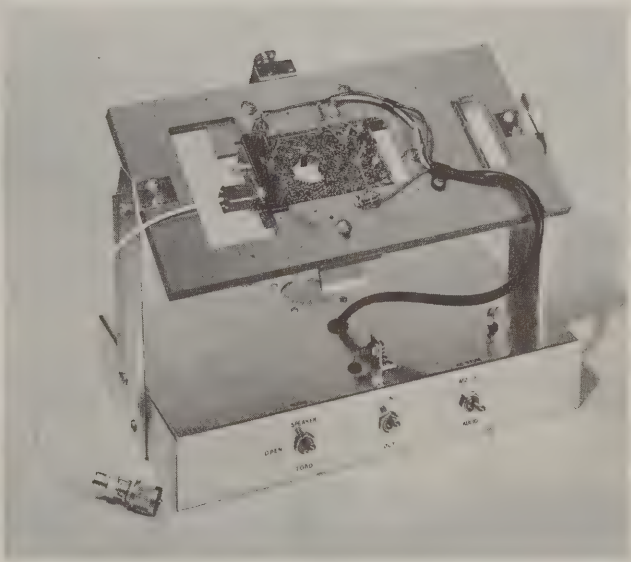
[5] The signal generator should be adjusted to minimum output.

[6] The AC voltmeter is connected to the AC meter terminals on the back of the test fixture. The AC voltage should be approximately -47 db of noise.

[7] Now increase the output from the signal generator until the reading increases to -37 db.

The amount of signal from the generator required to do this will be approximately .25uv to .42uv.

If these voltages are attained, it would indicate that the complete front end of the receiver is functioning properly. If not, refer to the stage-by-stage analysis charts.



HT220 MOUNTED IN TEST FIXTURE NEN6072A, WITH ADAPTER CABLE NKD6001A.

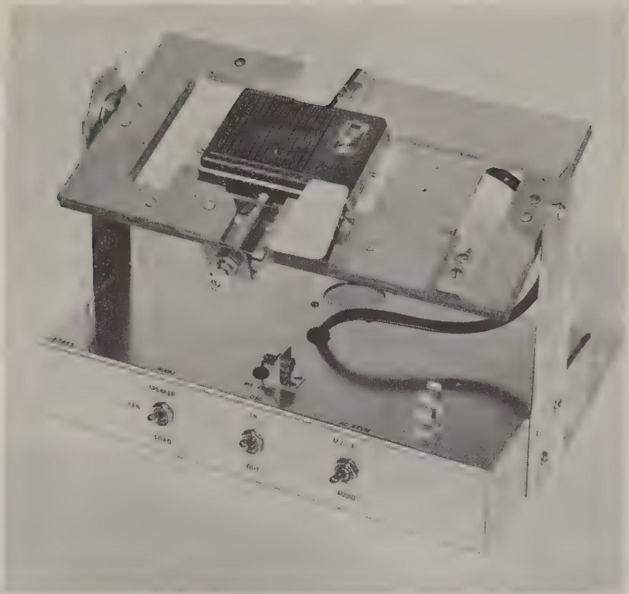
Figure 31.

(4) Carrier Squelch Sensitivity Measurement

(a) Introduction

This procedure is used to test the function of the squelch circuitry in the receiver.

With no r-f input signal, adjust the squelch control until the speaker noise just cuts out (threshold squelch). The signal level at which the squelch begins to open is referred to as the squelch threshold sensitivity level.



HT100 MOUNTED IN TEST FIXTURE NEN6072A.

Figure 32.

This signal should be 1/2 of the 20 db quieting sensitivity level of .18 uv or less.

(b) Step-by-step procedure for performing a Squelch Sensitivity Measurement.

[1] With the radio mounted in the test fixture, supply voltage connected to the unit. The radio turned ON.

[2] Adjust the Squelch control until noise can be heard at the speaker (minimum squelch).

[3] Adjust the signal generator to carrier frequency, and for minimum RF output. The signal generator is connected to the radio through RF adapter cable NKD6001A.

[4] Then adjust the squelch control until the speaker noise just cuts out (threshold squelch).

[5] Increase the RF output level from the signal generator until the squelch begins to open (noise heard in the speaker).

[6] The level of RF signal required to open the squelch is the squelch threshold sensitivity level. This signal level is 1/2 or less of the 20 db quieting sensitivity level, which is .18 uv or less.

This completes the squelch sensitivity measurement.

3. Transmitter: Performance Measurements

a. Preliminary Bench Tests

(1) With the radio turned on, key the transmitter into a field strength meter to check the continuity of the antenna connection. If a field strength indication is obtained proceed to next step.

(2) With the radio turned on, key the transmitter into a dummy load (Model 6154 Bird termaline) using adapter cable # NKD6001A and check for rated power output. If defective, refer to the alignment procedure and the transmitter RF Stage Gain measurements chart.

(3) Power output OK. Then check the transmitter voice modulation by whistling into the microphone and check for 5 KHz deviation. If defective, refer to the TX alignment procedure & the transmitter audio measurements chart.

(4) If power output is OK and transmitter voice modulation checks good then transmit frequency should be checked and adjusted if necessary.

If necessary, proceed to the detailed servicing measurements.

b. Detailed Transmitter Measurements using NEN6072A Test Fixture.

(1) Introduction

This section contains recommended servicing measurements for the transmitter, using the NEN6072A test fixture and the NKD6001A adapter cable.

Several recommended servicing measurements are listed below, along with a step-by-step testing procedure for performing these measurements.

The testing procedures apply to the HT100 as well as the HT220 when using the NEN6072A test fixture and the NKD6001A adapter cable.

(a) Check for rated power output and maximum current drain specifications.

(b) Check transmitter RF frequency.

(c) Transmitter audio deviation check.

(2) Transmitter Power Output

(a) An overall check of the transmitter RF circuits is a power output measurement. This performance check, checks the oscillator multipliers, driver and final power amplifier stages.

(b) STEP-BY-STEP PROCEDURE FOR A POWER OUTPUT CHECK

1 With the radio mounted in the test

fixture, 150.0V DC supply voltage connected to the unit, radio turned on.

[2] Connect the RF adapter cable NKD6001A to the antenna connector on the HT.

[3] Connect the RF adapter cable to a watt meter for accurate measurements.

[4] Press the transmitter Push-to-Talk switch with the spring loaded button on the test fixture.

[5] A correct power output indication is 1.8 watts for the HT220 and .5 watts for the HT100. If these levels are not attained refer to the transmitter alignment procedure and the RF stage gain chart.

(3) Transmitter Audio Deviation Check

(a) An accurate and standard procedure is recommended in setting transmitter audio deviation. The ease and technique used with the Test Fixture (NEN 6072A) is explained below.

(b) Procedure

[1] The regulated power supply connected to the power terminals on the back of test fixture is adjusted for 15.0V DC.

[2] The audio oscillator is connected to the osc. terminals on test fixture.

[3] The AC voltmeter is connected to the AC VTVM terminals on the test fixture.

[4] With the radio mounted in the test fixture, unit turned on.

[5] RF adapter cable NKD6001A connected to the antenna connector on the HT and the other end of the cable connected to a dummy load.

[6] Press the transmitter Push-to-Talk switch.

[7] With the osc. switch on the front panel of the test fixture in the out position, adjust the audio oscillator for 0.1 volts AC (-17 db) on AC VTVM.

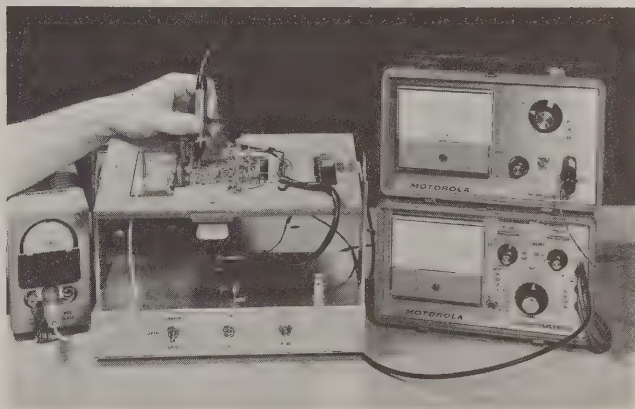
[8] Now switch the oscillator "in-out" switch on the front panel of the test fixture to the "IN" position.

[9] At this time the transmitter audio circuitry should be in full clip (limiting), and the IDC control (R119) should be adjusted for ±5 KHz audio deviation. The amount of audio deviation is observed on a properly calibrated oscilloscope. The oscilloscope must be used in conjunction with a receiver which has a stable discriminator characteristic, such as a Motorola portable test set with deviation panel Model S1059A, or a Digital Frequency Meter with Deviation Panel Model S1078B.

[10] To check the sensitivity of the transmitter audio section, switch the oscillator "In-Out" switch to the "out" position. Then adjust the Oscillator output for 8.0 mv (-40 db) on the AC VTVM.

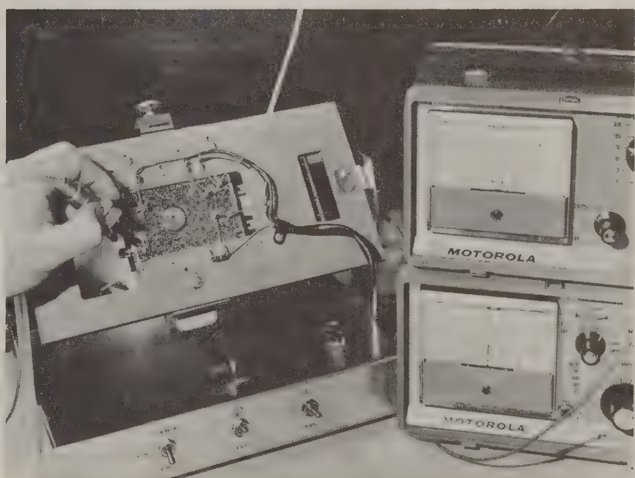
[11] Now switch the Osc. "In-Out" switch to the "IN" position.

[12] Transmitter deviation should be no less than 3.3 KHz.



PERFORMANCE OF RF GAIN MEASUREMENTS IN THE TRANSMITTER USING THE DC MULTIMETER WITH RF PROBE.

Figure 33.



THE METERS ARE HOOKED UP IN A STANDARD TEST BENCH SETUP TO PERFORM RF STAGE GAIN MEASUREMENTS USING THE TEK10 FOR RF INJECTION.

Figure 34.

STEP NUMBER	SIG. GEN. INJECTION POINT	SIG. GEN. INJECTION LEVEL		RECEIVER METERING POINT	REFERENCE VOLTAGE	REMARKS
1	Antenna Connection	3uv	-98db	All measurements taken using M2 as a reference.	A reference voltage of -30db is used.	The input level which is required to produce the -30db reference voltage at M2.
2	Q1 Base	2.2uv	-100db			Input level required at Q1 Base to produce the -30db reference reading. This also indicates a 2db insertion loss in the antenna input circuits.
3	Q1 Collector	35uv	-76db			Input level required at Q1 Collector to produce the -30db reference reading. This would indicate a +24db gain of Q1. 100db Q1 Base level 76db Q1 Collector level 24db difference = +24db Gain

Receiver Stage Gain Measurements

Figure 35.

F. TROUBLESHOOTING PROCEDURES

1. Stage Gain Measurements - Refer to Figure 35

a. Receiver

(1) RF Stage Gain Measurements

Preliminary steps:

(a) Mount the HT in the test fixture.

(b) Connect to power supply to power terminals on the test fixture.

(c) Connect the TEK-10 RF injection probe to the signal generator cable.

(d) With the AC Voltmeter connected to the AC output connectors on the test fixture use the -30 db range as a reference scale.

(e) Switch the "M2 and Audio" switch to the M2 position.

(f) Then adjust the output of the signal generator for a reading of -30 db on the AC Voltmeter with the generator adjusted for carrier frequency.

(2) RF Stage Gain Measurements on the Receiver - Refer to Figure 36

Preliminary Steps:

(a) Mount the HT in the test fixture # NEN6072A.

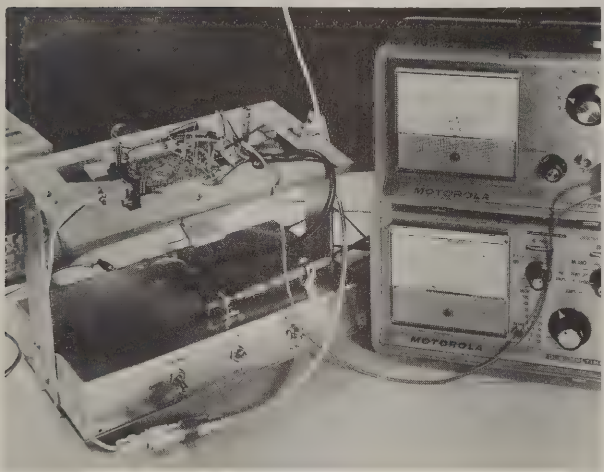
(b) Connect the HT to an external power supply and adjust the input for 15.0V DC.

(c) Connect the HT antenna to the T1034C signal generator with the use of an adapter cable #NKD6001A.

(d) All meter reading taken with a Motorola S1052B DC Multimeter, with RF Probe SLN6055.

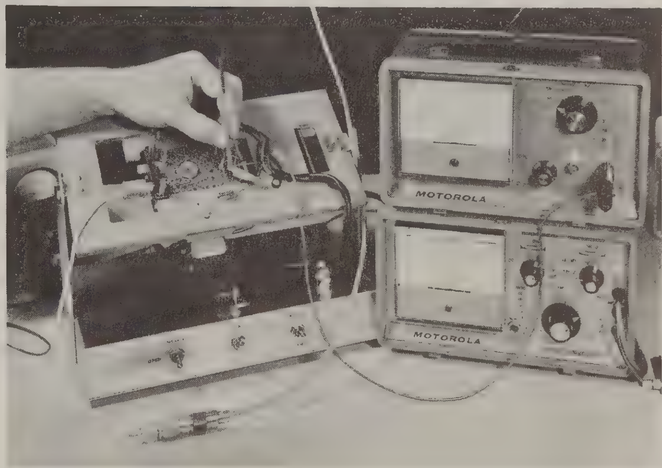
(e) The RF reference reading on the DC Multimeter is indicated in each step.

When using the DC Voltmeter with RF Probe it is not practical to make a stage gain check of the 455KC (ceramic) IF Filter. So refer to figure 42 for these measurements.



TYPICAL BENCH SETUP USING THE EXTRA HAND PROBE AS A METERING PROBE FOR TAKING AC STAGE GAIN MEASUREMENTS IN ANY SPECIFIC CIRCUIT.

Figure 37.



THE SAME AC VOLTAGE READING AS WITH THE USE OF THE EXTRA HAND PROBE.

Figure 38.

STEP NUMBER	SIG. GEN. INJECTION POINT	SIG. GEN. INJECTION LEVEL		RECEIVER METERING POINTS	REFERENCE READINGS (RF VOLTAGES)	REMARKS
4	Input is connected to the antenna through an adapter cable # NKD6001A	5.5Kuv	-32db	Q1 Collector	.05V RF	The input required to produce a reference voltage reading.
5		180uv	-62db	Q3 Collector	.05V RF	30db Gain for Q3.
6		1.3Kuv	-45db	Q3 Collector	0.5V RF	A new reference level.
7		42uv	-74db	Q5 Collector	0.5V RF	29db Gain for Q5.
8		140uv	-64db	Pin#10 of IC1482	.03V RF	New reference level.
9		.4uv	-115db	Pin#4(M2) of IC1482	.03V RF	51db Gain of IC1482.
10		No input signal.		Pin#8 of IC1482	1.45V RF	This reading is in saturation with signal or noise and will produce the same RF reading.

Receiver R. F. Stage Gain Measurements
Figure 36.

STEP NUMBER	SIG. GEN. INJECTION POINT	SIG. GEN. INJECTION LEVEL	RECEIVER METERING POINTS	AC VOLTAGE READINGS		REMARKS
11	The Signal Generator is connected to the Antenna connector of the HT.	The injection level is 1000uv at 3.3 KHz of deviation and a Frequency of 1000 Hz.	M4	250mv	-10db	This is the AC Voltage at the output of the discriminator.
12			Q7 Emitter	240mv	-10db	Output of the active filter ckt.
13			Between R33 & C54 (Q12B ckt.)	14mv	-35db	AC level at the output of the volume control.
14			Q12 Collector	100mv	-18db	17db gain of Q12.
15			Q14 Collector	4.8V AC	+16db	34db gain of Q14.
16			Q15 & Q16 Emitters	4.6V AC	+15db	Output from the final Audio circuit.
17			Across the Speaker	4.5V AC	+15db	The AC voltage is developed across the 40 ohm speaker or across the Audio output terminals on the test fixture.

Receiver Audio Gain Measurements

Figure 39.

(3) Receiver Audio Stage Gain Measurements - Refer to Figure 39

Preliminary Procedures:

(a) Mount the HT in Test Fixture Model #NEN6072A.

(b) Connect the external power supply and adjust for 15V DC.

(c) Connect the signal generator (T1034C) to the antenna connection on the HT with the use of adaptor cable #NKD-6001A.

(d) Adjust the signal generator for 1000uv output @3.3kc Dev. with a 1000Hz signal.

(e) Use the Motorola S1053C AC Voltmeter for all stage gain readings.

(f) Adjust the volume control for -35db of signal @ a point between R33 & C54 which should be approximately 2/3 maximum volume.

(g) The test fixture "Speaker-Load" switch can be left in either the speaker or load position.

(4) Receiver Squelch Circuit
Noise Measurements - Refer to Figure 41

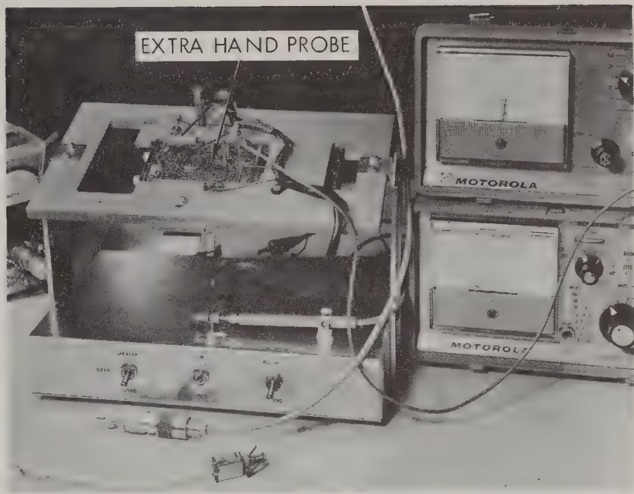
Preliminary Steps:

These measurements to be made if the Receiver is squelched all of the time or does not squelch at all. This is determined by adjusting the dquelch control from minimum to maximum squelch with the Radio turned on with 15V DC applied to the radio.

(a) AC Voltage measurements taken with a Motorola Model S1053C AC voltmeter.

(b) DC Voltage measurements taken with a Motorola Model S1052B DC multimeter.

(c) All measurements taken with noise only no signal applied at the antenna.



A CLOSE-UP SHOWING THE EXTRA HAND PROBE WITH THE AC VTVM CONNECTED TO IT, MEASURING THE NOISE AT THE INPUT OF THE SQUELCH CIRCUIT

Figure 40.

STEP NUMBER	MEASUREMENT POINTS	AC VOLTAGES		DC VOLTAGES	REMARKS
		With Rec. Unsquel.	With Rec. Full squel.		
18	Meter Position M4	-16db	-16db		Typical noise reading
19	Q8 Base	-34db	-34db		Noise input to squelch circuitry
20	Q8 Collector	+7db	+7db		Typical AC level at this point
21	Q9 Base	-45db	-12db		Noise level coupled across the squelch
22	Q9 Collector	-45db	-1db	0.9V DC	A squelch & unsquelch condition typical readings
23	Q10 Collector	---	---	1.6V DC	DC voltage in a full squelch condition
24	Q11 Base	---	---	0.6V DC	DC level with full squelch

Receiver Squelch Measurements

Figure 41.

(5) Receiver Stage Measurements of 455 KHz Filter - Refer to Figure 42

Preliminary Procedures:

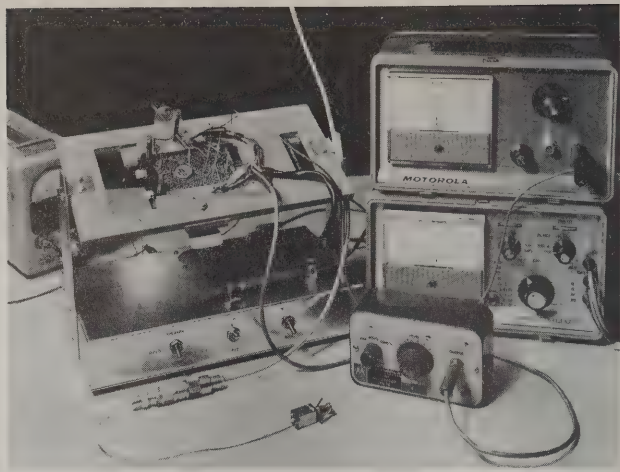
(a) Mount HT in Test Fixture # NEN6072A.

(b) Connect External Power Supply and Adjust for 15.0V DC.

(c) Connect Signal generator to the antenna connection on the HT with the use of adaptor cable # NKD6001A.

(d) A fixed input from the signal generator is used.

(e) Use Motorola AC voltmeter S1053C for all test measurements, with SKN6001A Test lead cable.



MAKING AUDIO STAGE GAIN MEASUREMENTS WITH TEK1A CONNECTED AT M4, THE EXTRA HAND PROBE MAKING CONTACT TO A STRIP OF PLATING IN THE AUDIO SECTION OF THE RECEIVER, WITH THE AC VTVM CONNECTED TO THE EXTRA HAND PROBE FOR METERING.

Figure 43.

INJECTION POINT	STEP NO.	INJECTION LEVEL	METERING POINT	AC VOLTAGE LEVEL	REMARKS
Antenna	7	5.0uv	Q5 Collector	-40db	AC level at the collector of Q5
Antenna	8	5.0uv	Pin #10 IC1482	-55db	15db loss of ceramic 455 KC filter

Receiver Filter Measurements
Figure 42.

(6) Alternate Method
Receiver Audio Stage Gain Measurements - Refer to Figure 44

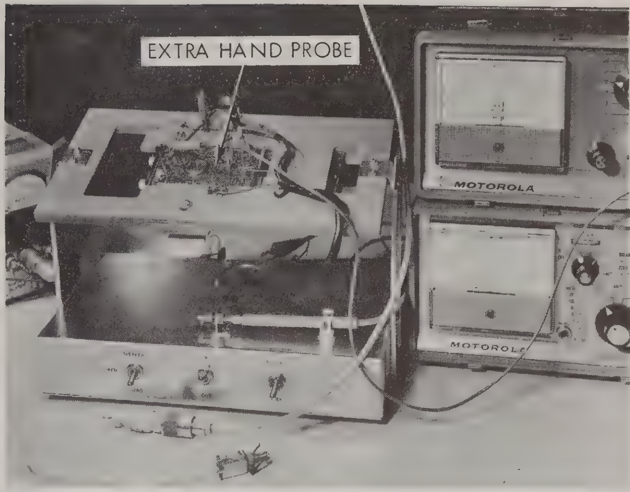
Preliminary Procedures:

(a) With the signal generator disconnected from the HT antenna.

(b) Connect the Audio Oscillator (Model S1067A) output to M4 in the receiver.

(c) Adjust the Audio Oscillator for a 1000Hz signal at 250 mv AC as measured by the Motorola AC Voltmeter S1053.

(d) Adjust the volume control for -35 db of audio @ the point between R33 & C54 (Q12 Base ckt.).



A CLOSE-UP SHOWING THE EXTRA HAND PROBE WITH THE AC VTVM CONNECTED TO IT, MEASURING THE NOISE AT THE INPUT OF THE SQUELCH CIRCUIT

Figure 45.

STEP NUMBER	AUDIO OSCILLATOR INJECTION POINT	AUDIO OSCILLATOR INJECTION LEVEL	RECEIVER METERING POINTS	AC VOLTAGE READINGS		REMARKS
1	The Oscillator is connected to M4 in the receiver.	The input level is 250mv AC with a 1000Hz signal.	M4	250mv	-10db	Reference level.
2			Q7 Base	240mv	-10db	Input level at this point.
3			Q7 Emitter	250mv	-10db	Output of Active Filter Q7.
4			Between R33 & C54 (Q12B circuit)	14mv	-35db	The volume control is adjusted for this AC level.
5			Q12 Collector	100mv	-18db	+17db Gain of Q12.
6			Q14 Collector	4.8V	+16db	+34db Gain of Q14.
7			Q15 & Q16 Emitters	4.6V	+15db	Output of the final Audio output stage.
8			Across Speaker	4.5V	+15db	The AC Voltage developed across the 40 ohm speaker or across the Audio output terminals on the test fixture.

Receiver Audio Measurements - Alternate Method

Figure 44.

AC VOLTAGES		NOISE ONLY NO CARRIER SIGNAL	
STEP NUMBER	METERING POINTS	VOLTAGES	REMARKS
1	M2		Perform a 10 db rise check to eliminate any problem in the front end of the receiver.
2	M2	-47db	This measurement can be made through the Test Fixture Setup.
3	Pin #8 of IC1482	+2db	Output of the 455 khz chip.
4	Q6 Base	-1db	AC level at the input to the limiter.
5	Q6 Collector	+4db	Limiter output.
6	M4	-16db	Noise voltage developed in the discriminator.
7	Between C51 & C52	-16db	AC voltage at one point in the active filter.
8	Between C52 & C53	-16.5db	AC voltage at another point in the active filter.
9	Q7 Base	-17db	Noise level at the base of Q7.
10	Q7 Emitter	-16db	The noise voltage which is applied to the squelch control.
11	Between R33 & C54	-29db	Full volume.
12	Q12 Base	-30db	Full volume.
13	Q12 Collector	-14db	Full volume.
14	Q14 Collector	+15db	Full volume.
15	Q15 & Q16 Emitter	+15db	Full volume.
16	Across Speaker	+14db	Full volume.

Receiver Servicing Noise Measurements - Alternate Method

Figure 46.

(7) Alternate Method
Receiver Servicing Noise Measurements - Refer to Figure 46.

Preliminary Steps:

With the receiver turned on and unsquelched with 15V DC applied to the radio there should be a high level of noise at the speaker, if not perform steps 1 thru 16.

INJECTION POINT	STEP NO.	INJECTION LEVEL	METERING POINT	AC VOLTAGE LEVEL	REMARKS
Antenna	1	5.0uv	Q5 Collector	-40db	AC level at the collector of Q5.
Antenna	2	5.0uv	Pin #10 IC1482	-55db	15db loss of ceramic 455 KC filter.
Antenna	3	1.0uv	Pin #10 of IC	-65db	A new reference for gain readings of the IC1482.
Antenna	4	1.0uv	Pin #4 M2	-24db	51db gain of IC.
Antenna	5	0uv	Q6 Base	-1db	This stage is in limiting and the reading should not vary with signal input.
Antenna	6	0uv	Q6 Collector	+5db	This reading should not vary with a carrier input either.
Antenna	7	0uv	M4	-16db	Noise reading.

455KC Filter and IC Measurements - Alternate Method

Figure 47.

(8) Alternate Method
Receiver Stage Gain Measurements of 455KC Filter & IC - Refer to Figure 47

Preliminary Procedures:

(a) Mount HT in Test Fixture # NEN6072A.

(b) Connect External Power Supply and adjust for 15.0V DC.

(c) Connect Signal generator to the antenna connection on the HT with the use of adaptor cable # NKD6001A.

(d) A fixed input from the signal generator is used, which is indicated in each step.

(e) Use Motorola AC voltmeter S1053C for all test measurements, with SKN6001A Test lead cable.

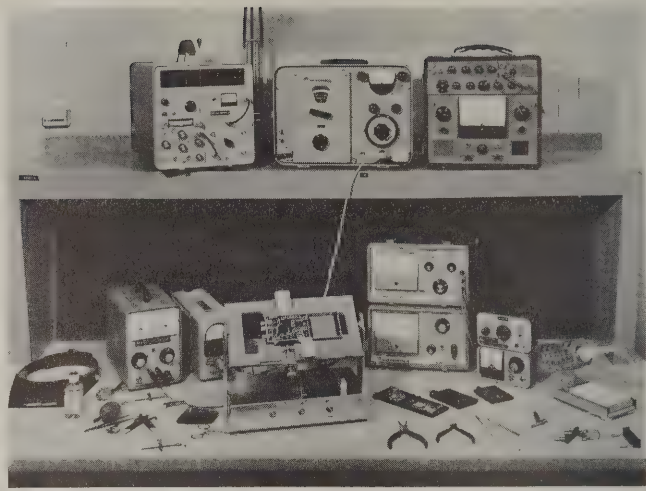
(9) Alternate Method
Receiver RF Stage Gain Readings of IC1482 & Limiter with a 455KC Signal from the Test Set - Refer to Figure 48

Preliminary Setup:

(a) Use a 455KC crystal controlled RF signal from the Motorola test set S1069A or equivalent.

(b) Inject this signal to the unused point on L6, & couple the signal with a .01 uf capacitor.

(c) Use the Motorola DC Multimeter with RF Probe for measuring signal levels.



A COMPLETE SERVICING BENCH SETUP

Figure 49.

INJECTION POINT	STEP NO.	INJECTION LEVEL	METERING POINT	REFERENCE LEVEL	REMARKS
Unused Point on L6	1	Maximum output from test set of 0.1V RF	IC Pin #10	Needle flickers on the .1V RF range.	Amount of input to the IC (integrated circuit).
"	2	"	Pin #4 M2	.07V RF	Typical level.
"	3	"	Pin #8	1.4V RF	This reading is in saturation and is an average measurement for all radios
"	4	"	Q6 Base	1.3V RF	Typical readings on noise or with a signal injected into the radio.
	5	"	Q6 Collector	2.2V RF	
"	6	"	M3	+2.2V DC	Typical voltage when tuning the primary and secondary of Disc.
"	7	"	M4	±.01V DC	Discriminator zero voltage.

Receiver IC and Limiter Measurements - Alternate Method

Figure 48.

b. Transmitter RF Measurements - Refer to Fig. 54.

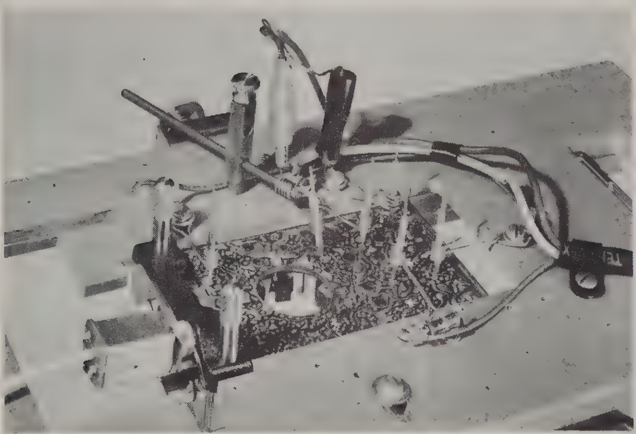
Preliminary Procedures:

(1) Set portable in Test Fixture # NEN6072A.

(2) Connect external Power Supply to HT & adjust for 15.0V DC input to the radio.

(3) Connect the watt meter to the antenna connector by the use of adapter cable # NKD6001A.

(4) Use a Motorola DC Multimeter S1052B with RF Probe SLN6055A for the RF Gain Readings.



THE UNIVERSAL EXTRA HAND PROBE USED FOR METERING.

Figure 50.

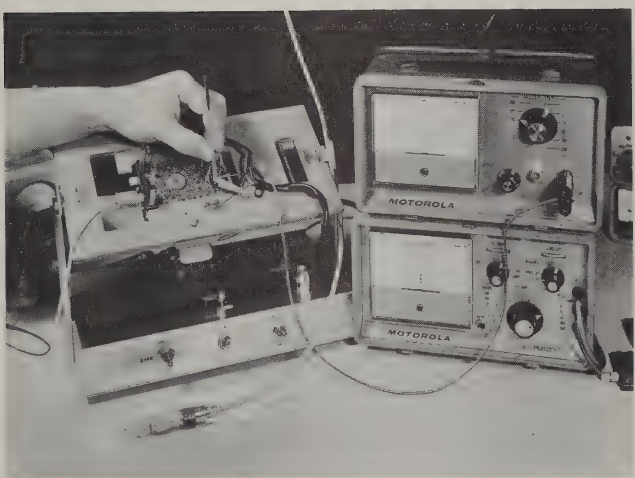
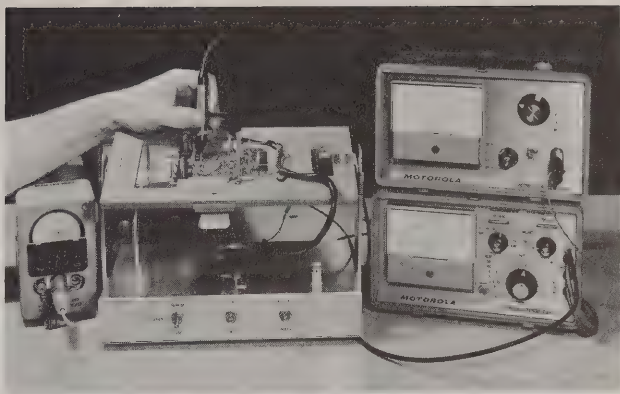
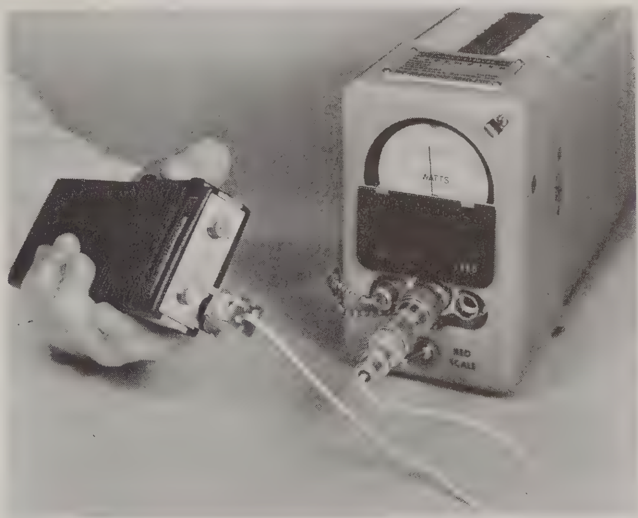


Figure 51.



PERFORMANCE OF RF GAIN MEASUREMENTS IN THE TRANSMITTER USING THE DC MULTIMETER RF PROBE

Figure 52.



PRELIMINARY POWER OUTPUT CHECK USING ADAPTER CABLE NKD 6001A.

Figure 53.

STEP NUMBER	MEASUREMENT POINT		RF VOLTS WITH TRANSMITTER COMPLETELY TUNED
1	HI SIDE Crystal	Activity	1.5V RF
2	CR101	Anode	3.6V
3	Q101	Base	1.2V
4		Collector	.05V
5		Emitter	1.1V
6	Q102	Base	1.2V
7		Collector	3.5V
8	Q103	Base	1.0V
9	Q104	Base	1.6V
10	Q105	Base	1.7V

Transmitter R. F. Measurements
Figure 54.

G. SERVICE HINTS AND SUGGESTIONS

1. Use of Tools

CAUTION
PROPER SUB-MINIATURE REPAIR TECHNIQUES OF UNSOLDERING AND SOLDERING MUST BE USED IN RE-PLACING COMPONENTS IN THIS RADIO.

Excess heat on the board or unnecessary strain on printed circuit lands can break the bond between the plating and the board, causing possible irreparable damage.

DO

Do use the recommended 20 watt soldering iron.

Do use the proper sub-miniature hand tools.

Do use the proper test fixture to hold the radio.

Do use the solder sucker to clean out holes for ease of new component insertion.

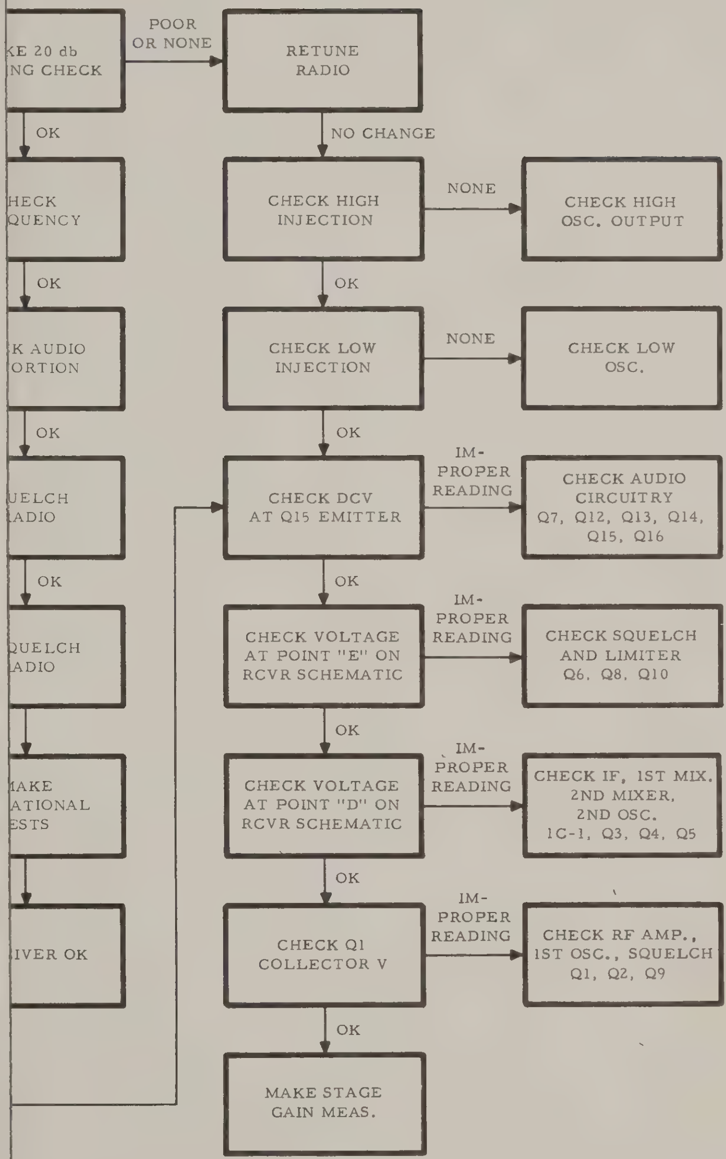
Do use the special IC soldering iron tip to heat all IC leads quickly and all at once.

DON'T

Don't use a large soldering iron.

Don't use excess heat.

Don't force component leads in holes not cleaned out properly.



ED
N-
AL

Figure 55.
Receiver Troubleshooting Chart

G. SERVICE HINTS AND SUGGESTIONS

1. Use of Tools

CAUTION
PROPER SUB-MINIATURE REPAIR TECHNIQUES OF UNSOLDERING AND SOLDERING MUST BE USED IN REPLACING COMPONENTS IN THIS RADIO.

Excess heat on the board or unnecessary strain on printed circuit lands can break the bond between the plating and the board, causing possible irreparable damage.

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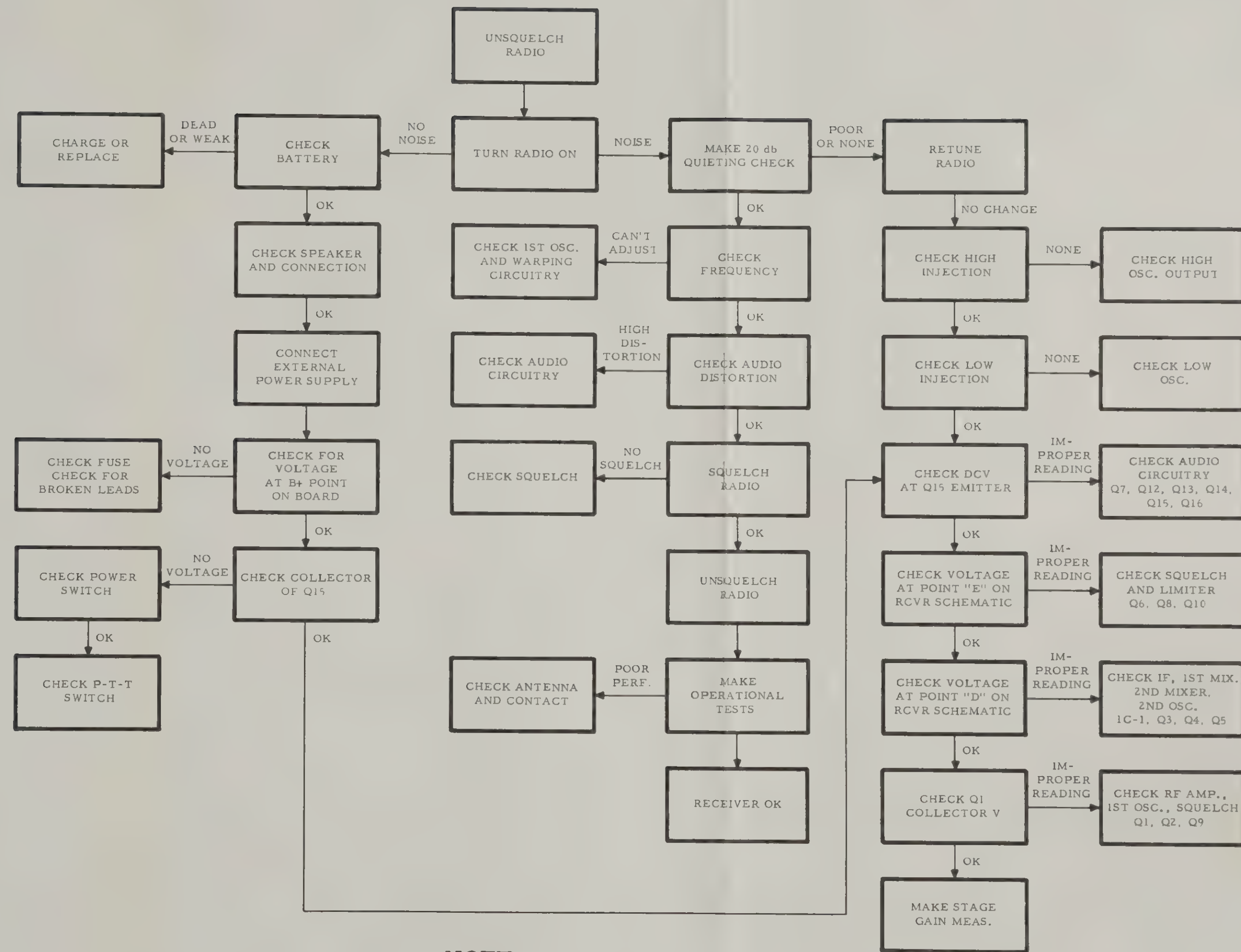
Don't use excess heat.

Don't force component leads in holes not cleaned out properly.



NOTE

The NKD6001A TUNE-UP CABLE MUST BE USED WHEN ALIGNING RECEIVER WITH SIGNAL GENERATOR IN ORDER TO SIMULATE THE ACTUAL IMPEDANCE OF THE ANTENNA.

Figure 55.
Receiver Troubleshooting Chart

NOTE
NE-UP CABLE MUST BE USED
RANSMITTER INTO A 50 OHM
RDER TO SIMULATE THE
CE OF THE ANTENNA. RE-
POWER WILL RESULT IF THE
IRECTLY INTO THE WATT-
THE TUNE-UP CABLE.

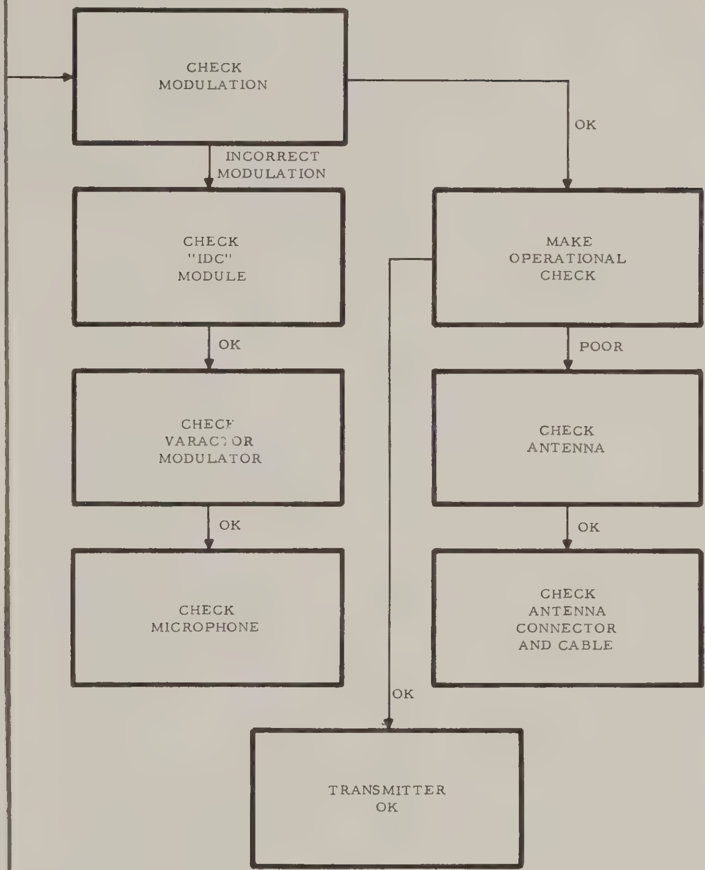


Figure 56.
Transmitter Troubleshooting Chart

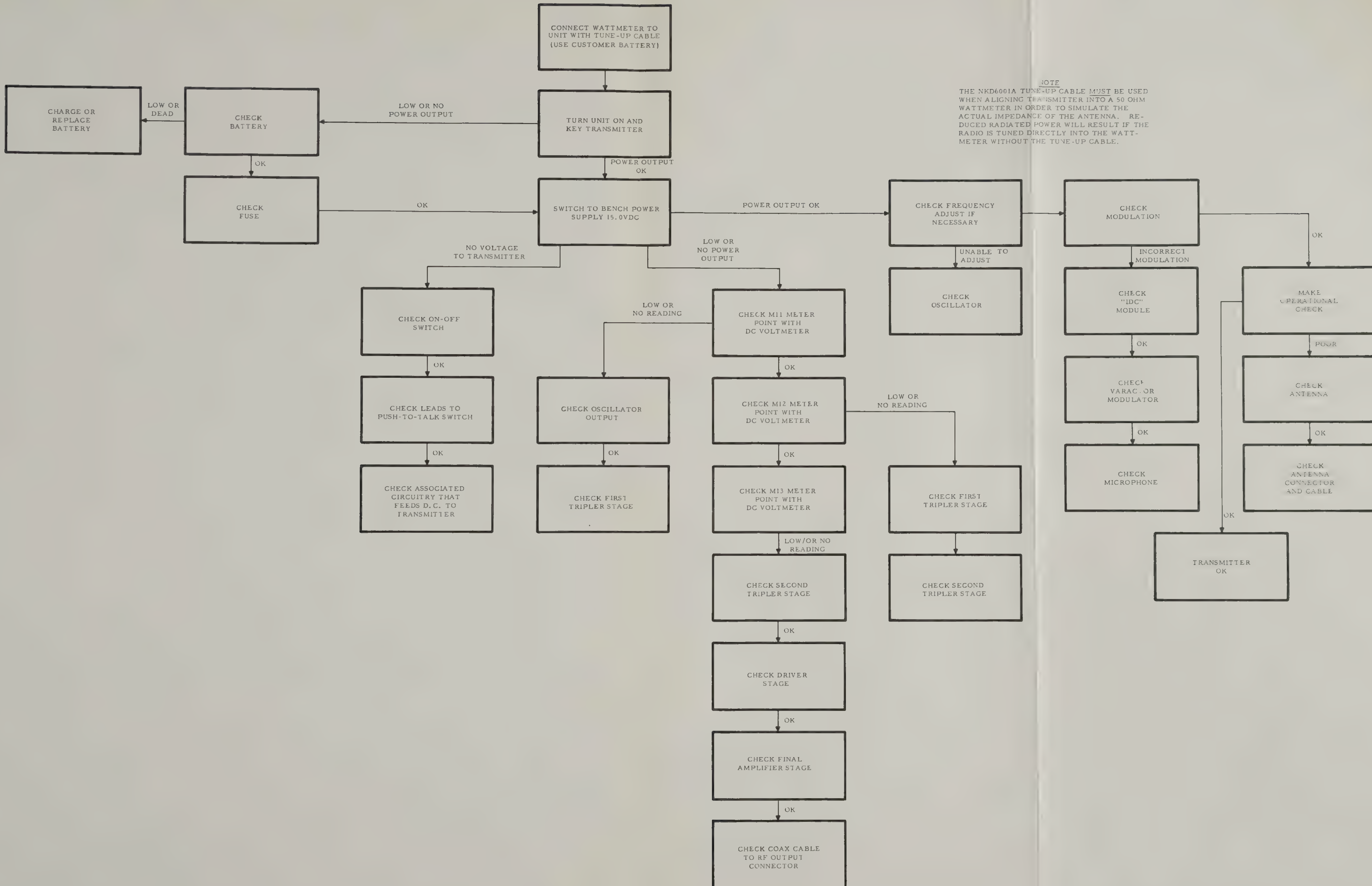
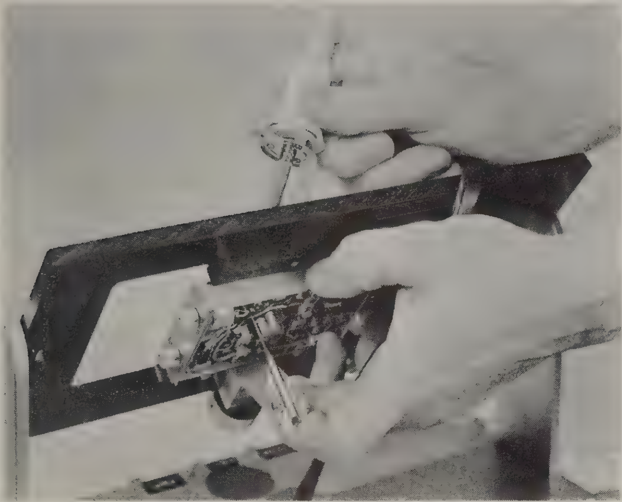


Figure 56.
Transmitter Troubleshooting Chart

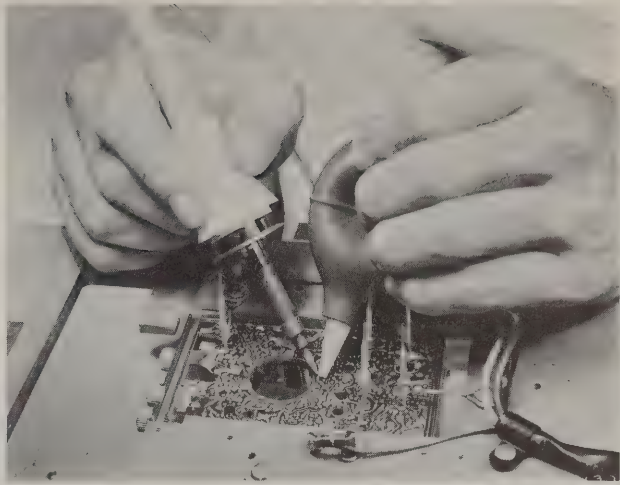


THE USE OF A FINGER PICK FOR CLEANING SOLDER OUT OF EYELITS IN THE PRINTED CIRCUIT BOARD. ST864

Figure 57.

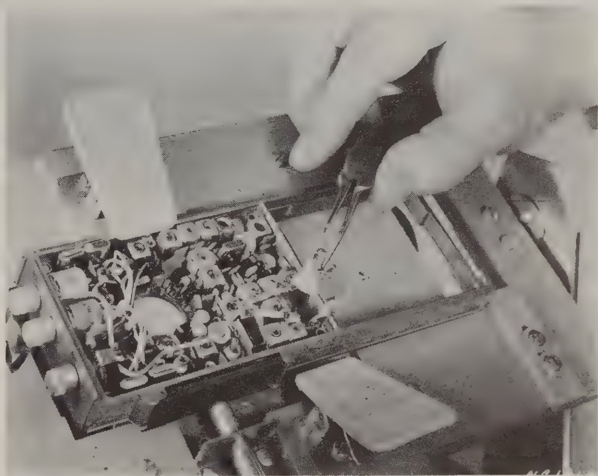
USE A HOOKED PICK (ST863) AS AN AID IN REMOVING COMPONENTS MOUNTED FLUSH ON THE BOARD.

Figure 58.



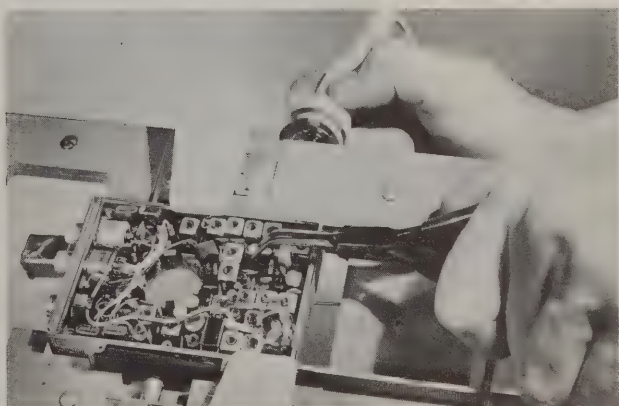
THE USE OF THE NEW MINI SOLDERING IRON (ST815) WITH THE DESOLDERING BULB (ST725) ARE RECOMMENDED.

Figure 59.



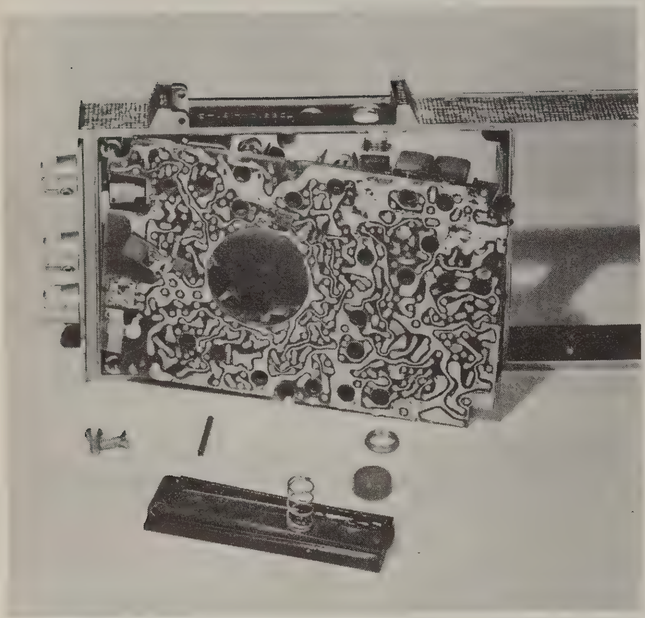
THE PROPER TECHNIQUE FOR DRESSING COMPONENTS IN THE REMOVAL OF THE TRANSMITTER FINAL TRANSISTOR ARE DEMONSTRATED, WITH CURVED LONG NOSE PLIERS ST866.

Figure 60.



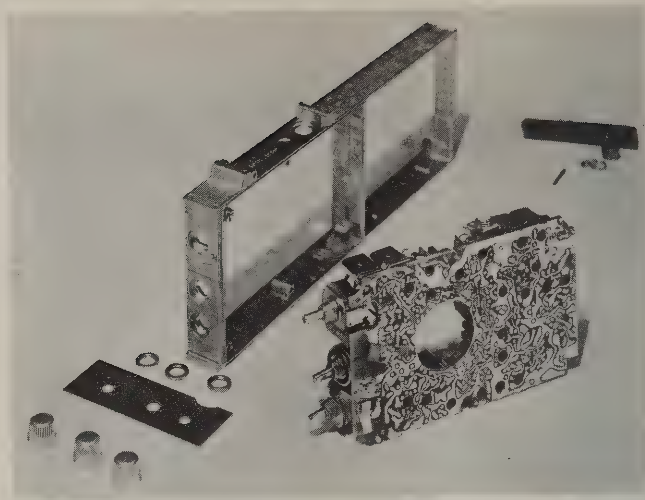
A PROPER TECHNIQUE FOR THE REMOVAL OF A CRYSTAL IS INDICATED, USING CURVED LONG NOSE PLIERS ST866.

Figure 61.



DISASSEMBLY PROCEDURE FOR THE REMOVAL OF THE PUSH-TO-TALK SWITCH.

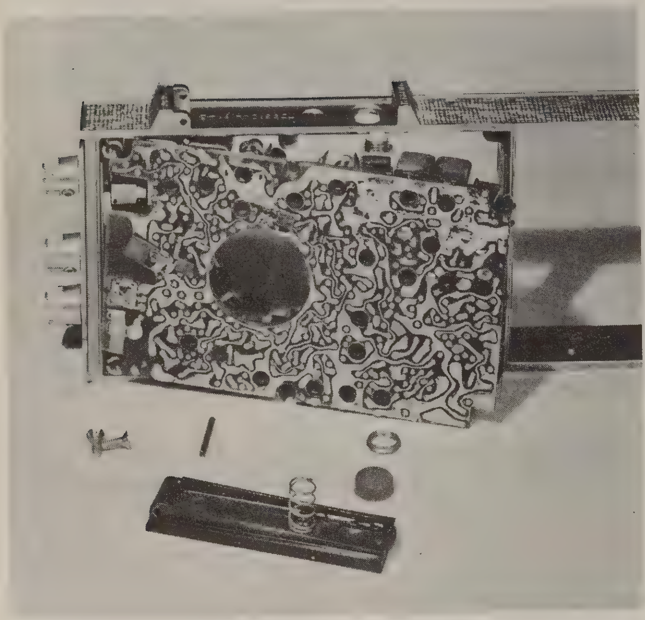
Figure 63.



DISASSEMBLY OF THE COMPLETE HOUSING.

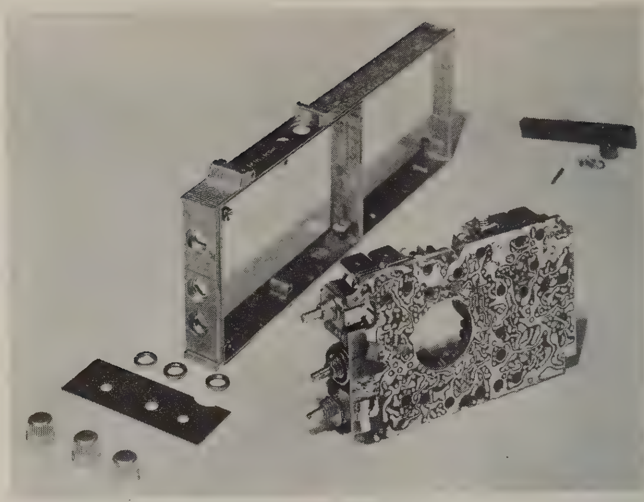
Figure 64.

Figure 62. Housing Removal



DISASSEMBLY PROCEDURE FOR THE REMOVAL OF THE PUSH-TO-TALK SWITCH.

Figure 63.

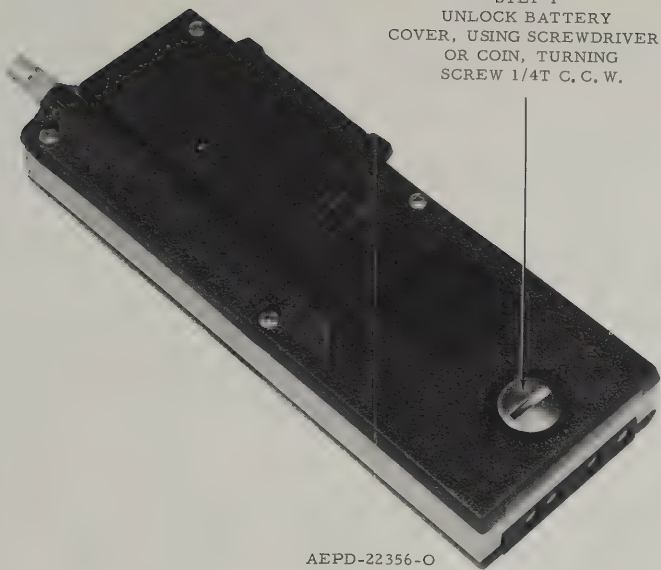


DISASSEMBLY OF THE COMPLETE HOUSING.

Figure 64.

DISASSEMBLY PROCEDURE

STEP 1
UNLOCK BATTERY
COVER, USING SCREWDRIVER
OR COIN, TURNING
SCREW 1/4T C. C. W.



AEPD-22356-O

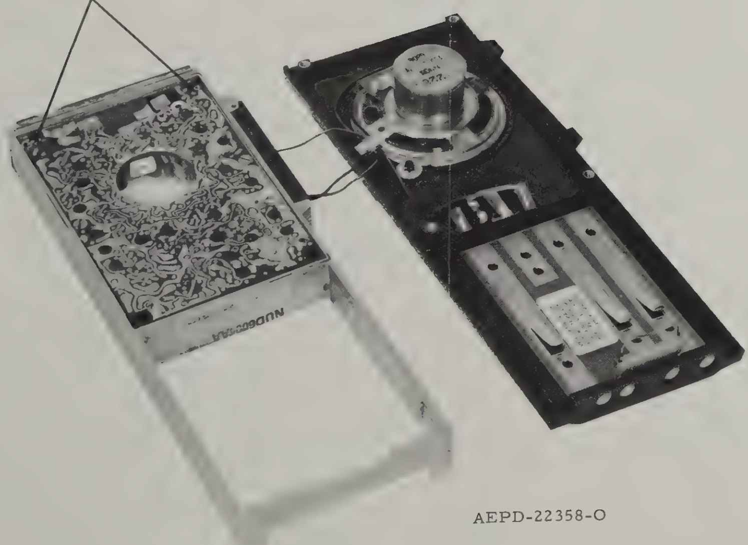
NOTES:

FOR ALL PARTS REPLACEMENTS EXCEPT VOLUME CONTROL, SQUELCH CONTROL, FREQUENCY SELECTOR SWITCH (IF USED), AND PUSH-TO-TALK SWITCH, THE RADIO SET REQUIRES NO FURTHER DISASSEMBLY. REFER TO ADVANCED DISASSEMBLY PROCEDURES IN ANOTHER SECTION OF THIS MANUAL FOR REPLACEMENT OR REPAIR OF ABOVE MENTIONED COMPONENTS.

ALL TRANSMITTER AND RECEIVER ALIGNMENT PROCEDURES MAY BE PERFORMED WITHOUT FURTHER DISASSEMBLY. ALL TRANSMITTER ALIGNMENT POINTS MAY BE TUNED WITH RADIO IN POSITION SHOWN IN STEP 4. RECEIVER 455 kHz FILTER ADJUSTMENTS (T5, L6) ARE MADE FROM THE COMPONENT SIDE OF RADIO SET CHASSIS.

EPD-22361-O

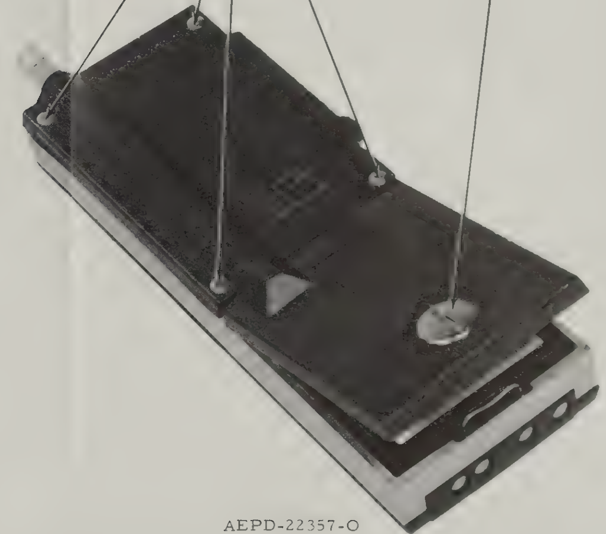
STEP 4
LOOSEN THE TWO CAPTIVE
BUSHINGS AND THEN
LIFT RADIO AND
MOVE FRONT COVER
ASSEMBLY TO SIDE



AEPD-22358-O

STEP 3
LOOSEN THE FOUR
CAPTIVE SCREWS
AND REMOVE RADIO
COMPARTMENT COVER

STEP 2
REMOVE BATTERY
COVER BY LIFTING
UP AND TOWARDS
BOTTOM OF RADIO



AEPD-22357-O

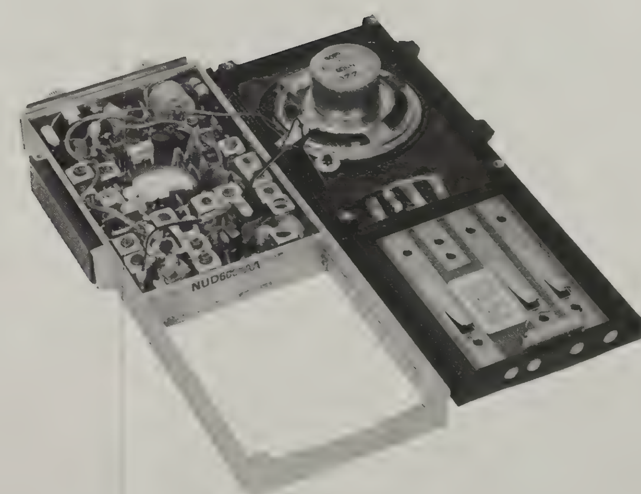
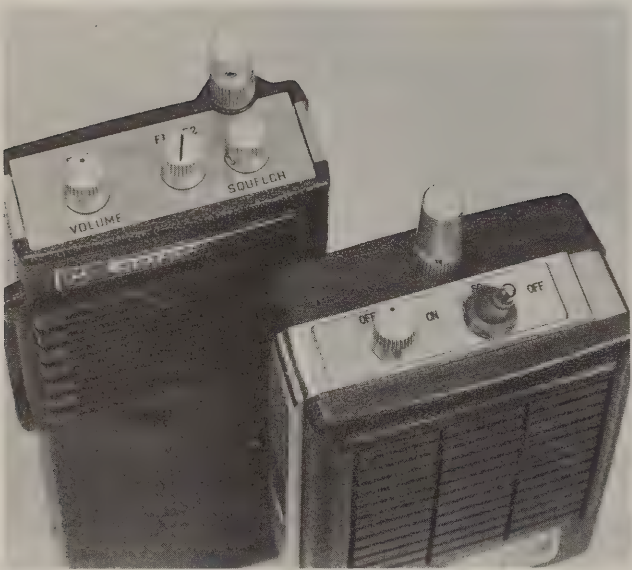


Figure 62. Housing Removal

STEP	TEST EQUIPMENT	METER POINT	ADJUSTMENT	PROCEDURE
1	DC Multimeter	M_3	T_6	Connect the 455 kHz output of the test set to the unused tap of L_6. With the DC Multimeter monitor M_3 and tune T_6 to the second peak. Typical reading is +2.2v dc.
2	DC Multimeter	M_4	L_7	With the set up in step 1, monitor the discriminator output M_4. Tune L_7 for zero volts. Tune to the second zero reading. This setting should be within ±.01v dc of zero volts.
3	DC Multimeter	M_4	Signal Generator	Set RF signal generator to 50,000 uv and adjust to the desired frequency. Monitor M_4 for zero volts.
*4	AC Voltmeter T1034C Signal Generator and NKD6001A Tune-up Cable	M_2	L_1, T_1, T_2, T_3, L_4, L_5, T_4, T_5, L_6	Tune L_1, T_1, T_2, T_3, L_4, L_5, T_4, T_5, L_6 for a maximum reading at M_2. Keep the M_2 reading below -30 dbm by reducing the signal generator input. Retune the coils to make sure they are peaked. On 2 frequency radios with 0.3 to 2.0 MHz, separation, L_1, T_1, T_2, T_3, must be balance tuned. Note: T_5 and L_6 must be tuned carefully with the signal generator set to discriminator zero ±.01v dc.
5	DC Multimeter	M_4	L_2	Use the base station transmitter or a frequency standard as a signal source and adjust L_2 for a zero DC voltage at M_4.
6	DC Multimeter	M_4	L_{301}	Repeat step 5 for the second frequency on two frequency radios.
7	AC Voltmeter T1034C Signal Generator and NKD6001A Tune-up Cable	Speaker	Signal Generator	Adjust the volume control for an output voltage across the speaker of O dbm (noise only - no signal output). Increase the input signal until the noise is reduced to one tenth of the reading with no signal. Read the attenuator scale in microvolts. This is the 20db quieting sensitivity and should be less than 0.35uv.

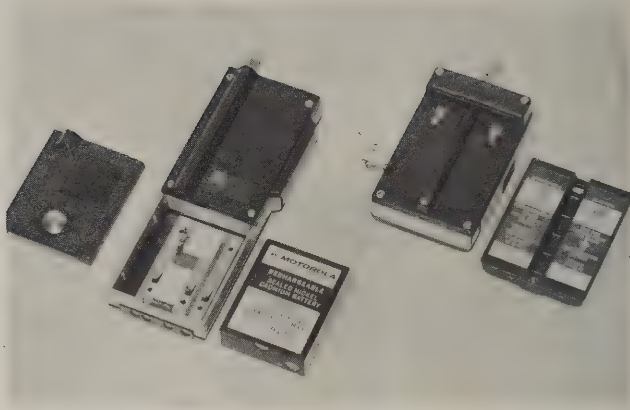
* ***CAUTION*** **:** After completing this step, look for the image frequency at 910 kHz <u>below</u> this setting as a check on the accuracy of the signal generator setting. Upon locating the image, return to the proper setting for the carrier frequency.

Figure 65.
Receiver



HT220 & HT100 "HANDIE-TALKIE" FM PORTABLE RADIO.

Figure 70.



HT220 & HT100 WITH THEIR RESPECTIVE NI CAD BATTERIES.

Figure 71.

JIPMENT	METER POINT	ADJUSTMENT	PROCEDURE
neter	M_3	T_6	Connect the 455 kHz output of the t test set to the unused tap of L_6. With the DC Multimeter monitor M_3 and tune T_6 to the second peak. Typical reading is +2.2v dc.
neter	M_4	L_7	With the set up in step 1, monitor the discriminator output M_4. Tune L_7 for zero volts. Tune to the second zero reading. This setting should be within ±.01v dc of zero volts.
neter	M_4	Signal Generator	Set RF signal generator to 50,000 uv and adjust to the desired frequency. Monitor M_4 for zero volts.
eter ignal and \ Tune-up	M_2	L_1, T_1, T_2, T_3, L_4, L_5, T_4, T_5, L_6	Tune L_1, T_1, T_2, T_3, L_4, L_5, T_4, T_5, L_6 for a maximum reading at M_2. Keep the M_2 reading below -30 dbm by reducing the signal generator input. Retune the coils to make sure they are peaked. On 2 frequency radios with 0.3 to 2.0 MHz, separation, L_1, T_1, T_2, T_3, must be balance tuned. Note: T_5 and L_6 must be tuned carefully with the signal generator set to discriminator zero ±.01v dc.
neter	M_4	L_2	Use the base station transmitter or a frequency standard as a signal source and adjust L_2 for a zero DC voltage at M_4.
neter	M_4	L_{301}	Repeat step 5 for the second frequency on two frequency radios.
eter ignal and \ Tune-up	Speaker	Signal Generator	Adjust the volume control for an output voltage across the speaker of O dbm (noise only - no signal output). Increase the input signal until the noise is reduced to one tenth of the reading with no signal. Read the attenuator scale in microvolts. This is the 20db quieting sensitivity and should be less than 0.35uv.

ON: After completing this step, look for the image frequency at
Iz below this setting as a check on the accuracy of the signal
tor setting. Upon locating the image, return to the proper
; for the carrier frequency.

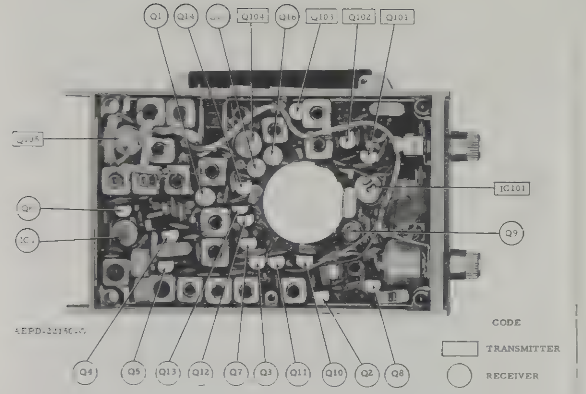
Figure 66. Receiver Alignment Procedure

HT220 & HT100 "HANDIE-TALKIE" FM PORTABLE RADIO.

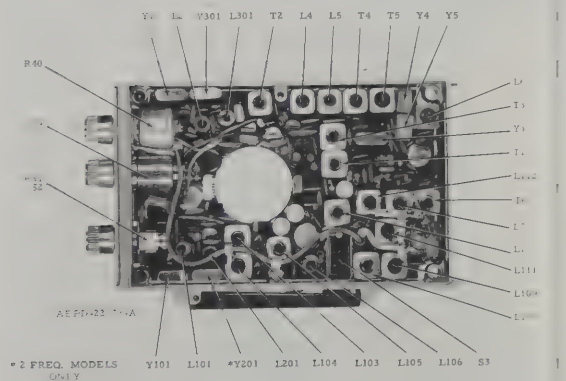
Figure 70.

HT220 & HT100 WITH THEIR RESPECTIVE NI CAD BATTERIES.

Figure 71.



Transistor Location Detail



Parts Location Detail

RECEIVER RF AND IF STAGE GAIN MEASUREMENTS CHART

1. Test Equipment Required
   a. DC multimeter with rf probe.
   b. AC voltmeter.
   c. Laboratory type rf voltmeter.
   d. Motorola Model T1034C Signal Generator, or equivalent.
   e. Motorola Model NKD6001A Tune-up Cable.

2. Notes
   a. Connect the Motorola Model T1034C Signal Generator to the radio set using the Motorola Model NKD6001A Tune-up Cable.
   b. All measurements are taken using 15.0 vdc input.
   c. When measuring rf voltages, connect the ground clip to the nearest ground point at the element being measured
   d. For noise readings, the signal generator frequency must be set to a frequency removed from the carrier frequency.
   e. Steps 1 and 3 provide a measure of oscillator activity.
   f. Steps 2 and 4 provide a measurement of high and low oscillator injection.
   g. In steps 5 through 10, repeak the coils as necessary for a peak reading. The tuning of the coils may be different for each type of meter.
   h. After completing the stage gain measurements, retune the receiver according to the receiver alignment procedure.
   i. All readings indicated in the chart are for a normally operating receiver.
   j. A malfunctioning receiver will cause the chart readings to differ.

STEP	UV INPUT	METER POINT	READINGS IN MICROVOLTS		
			LAB. RF VOLTMETER	AC VOLTMETER	DC VTVM (With RF Probe)
1	Noise	Emitter Q2	.70	-----	.67
2	Noise	Base Q3	.12	-----	.06
3	Noise	Emitter Q4	.90	-----	.80
4	Noise	Base Q5	.08	-----	.04
5	10,000	Collector Q1	.20	-----	.08
6	10,000	Base Q3	.30	-----	.10
7	1,000	Collector Q3	.70	-----	.65
8	1,000	Base Q5	.11	-----	.06
9	100	Collector Q5	.70	-----	.60
10	100	Pin 10 IC-1	.03	-28 dbm	.015
11	Noise	M2	---	-40 dbm	---

AUDIO AMPLIFIER MEASUREMENTS CHART

1. Test Equipment Required
   a. Motorola Model T1034C Signal Generator, or equivalent.
   b. Motorola Model NKD6001A Tune-up Cable.
   c. Motorola AC Voltmeter, or equivalent.

2. Notes
   a. Connect the Motorola Model T1034C Signal Generator to the radio set using the NKD6001A Tune-up Cable.
   b. Modulate the signal generator with a 1000 Hz tone adjusted to 3.3 kHz deviation. Tune the signal generator to the carrier frequency (zero reading at test point M4) and set the rf input signal to 100 microvolts.
   c. The readings shown in the chart are taken with an AC voltmeter.
   d. All measurements are taken using a 15.0 volt dc input.
   e. Adjust the volume control for rated audio output.

STEP	INPUT	METER POINT	READINGS
1	100 uv	M4	-13 dbm
2	100 uv	Emitter Q7	-12 dbm
3	100 uv	Base Q12	-40 dbm
4	100 uv	Emitter Q15	+16 dbm
5	100 uv	Speaker	+15 dbm

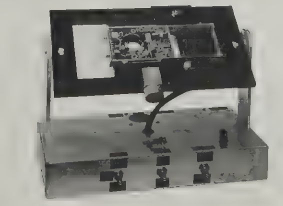
SQUELCH MEASUREMENTS CHART

1. Test Equipment Required
   a. Motorola AC Voltmeter, or equivalent.
   b. Motorola DC Multimeter, or equivalent.
   c. Motorola Model T1034C Signal Generator and Model NKD6001A Tune-up Cable.

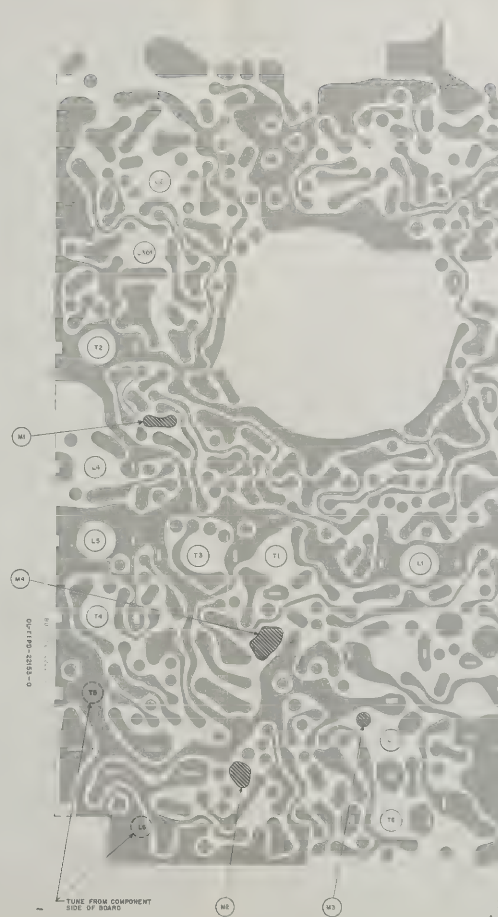
2. Notes
   a. Set the squelch control fully clockwise.
   b. Connect the Motorola Model T1034C Signal Generator to the radio set using the Model NKD6001A Tune-up Cable.
   c. All measurements are taken with 15.0 vdc input.
   d. For noise readings the signal generator frequency must be set to a frequency removed from the carrier frequency.

STEP	INPUT	METER POINT	READINGS	
			AC VOLTMETER	DC MULTIMETER
1	Noise	Collector Q8	+8.5 dbm	-----
2	Noise	Collector Q9	-----	.9 v
3	Noise	Collector Q10	-----	1.6 v
4	Noise	Base Q11	-----	.6 v

NOTE
The NKD6001A Tune-up Cable must be used when aligning receiver with signal generator in order to simulate the actual impedance of the antenna.



Radio Set
In Test Jig



Receiver Metering
And Alignment Points

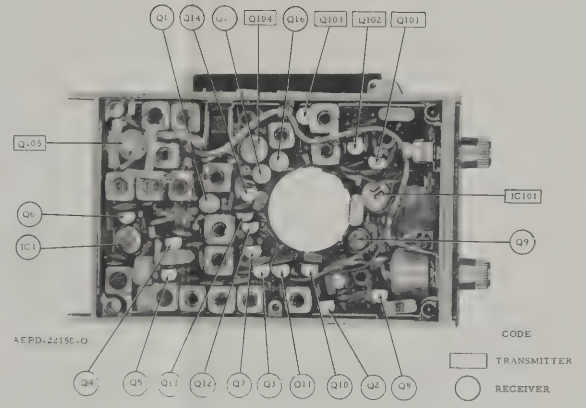
STEP	TEST EQUIPMENT	METER POINT	ADJUSTMENT	PROCEDURE
1	DC Multimeter	M_3	T_6	Connect the 455 kHz [illegible] test set to the unused tap of L_6. With the DC Multimeter monitor M and tune T_6 [illegible]. Typical reading is +2.2v dc.
2	DC Multimeter	M_4	L_-	[illegible] the discriminator output M_4. Tune L_- for zero volts. Tune to the second zero reading. [illegible] volts.
3	DC Multimeter	M_4	Signal Generator	[illegible]
*4	AC Voltmeter T1034C Signal Generator and NKD6001A Tune-up Cable	M_2	L_1, T_1, T_2, L_-, L_4, L_5, T_4, T_5, L_6	Tune L_1, T_1, T_-, T_-, L_-, L_-, T_-, T_- [illegible] by reducing the signal generator input. Retune the coils to make sure they are peaked. On 2 frequency radios with 0.3 to 2.0 MHz, separation, L_1, T_1, T_2, T_3, must be [illegible] be tuned carefully [illegible] generator set to dis[illegible] ±.01v dc.
5	DC Multimeter	M_4	L_2	Use the base station transmitter or a frequency standard as a signal source and adjust L_2 for a zero DC voltage at M_4.
6	DC Multimeter	M_4	L_{301}	Repeat step 5 for the second frequency on two frequen[illegible].
7	AC Voltmeter T1034C Signal Generator and NKD6001A Tune-up Cable	Speaker	Signal Generator	Adjust the volume control for [illegible] output voltage across the speaker of 0 dbm (noise [illegible] output). Increase the input signal until the noise is reduced to one tenth of the reading with no signal. [illegible] volts. This is the 20db quieting [illegible] than [illegible]

CAUTION After completing this step, look for the image frequency at 910 kHz below this setting as a check on the accuracy of the signal generator setting. Upon locating the image, return to the proper setting for the carrier frequency.

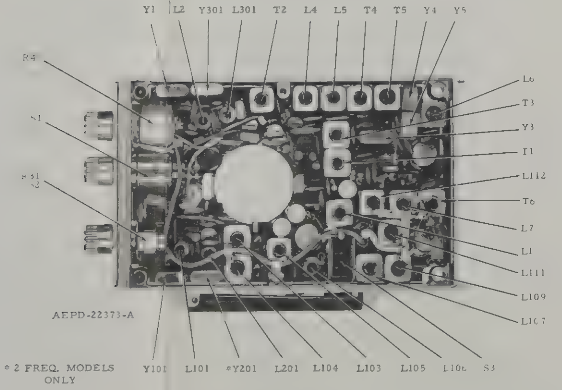
Figure 66. Receiver Alignment Procedure

NT	PROCEDURE
	OSCILLATOR: L101 is preset to the assigned frequency at the factory. Do not readjust L101 unless the crystal is replaced or the setting was accidentally changed. If it is necessary to readjust L101, set up the frequency monitor for frequency measurement, and adjust L101 for zero reading on the monitor CARRIER FREQUENCY meter. TWO-FREQUENCY TRANSMITTER ONLY OSCILLATOR NO. 2: Use the same procedure as above, substituting L201 for L101.
	Adjust power supply voltage for 15.0 v.
	NOTE: See step 1 above before performing this step. Tune L101 for a dip. On two-frequency models, switch to F2 and tune L201 for a dip.
	Tune L103 and L104 for a maximum reading. Re-tune these coils at least once to insure that a maximum has been obtained. This circuit is tuned to three times the crystal frequency.
	Tune L105 for a dip in the meter reading. This circuit is tuned to nine times the crystal frequency.
	Tune L106 for a maximum negative reading.
	Tune for maximum power output in pairs as follows: Tune L107 for maximum power output then L109, then repeak L107. Repeat for L111 and L112.
	Repeak L105 and L106 for maximum power output.
	Repeak L1'07 and L109 for maximum power output, then repeat using L111 and L112.
	Tune L112 until the current drain decreases to a current dip point. When this point is reached, adjust L112 until the total current drain is slightly above the minimum obtained in the dip and the power output is above that which occurs at the current dip. NOTE: If a current dip cannot be obtained, tune L112 until the current decreases and the power output is about 2.25 watts.
	Tune L111 into the board until the power output is about 2.0 watts.
	Tune L109 out of the board until the current drain decreases to about 330 ma. Then tune L107 for maximum power output and minimum current drain.
	Tune L112 and L111 for best power output and minimum current drain as follows: First increase the power output by tuning L112, and then tune L111 until 1.8 watts power output is obtained. If the current drain is greater than 310 ma, retune L112 and then tune L111. **NOTE** It may be necessary to readjust L109 while adjusting L111 and L112 for rated power output at the 310 ma current drain specification. TWO-FREQUENCY TRANSMITTERS ONLY Switch between F1 and F2 while tuning L107 and L109 for 1.8 w at 310 ma if the frequency separation is 1.0 MHz or less. Tune for 1.4 w at 310 ma on each channel if the frequency separation is between 1.0 MHz and 1.6 MHz.
	DEVIATION CHECK: See IDC ADJUSTMENT procedure on the reverse side of this chart for adjusting the IDC control. (R119)

Figure 67. Transmitter Alignment Procedure



Transistor Location Detail



Parts Location Detail

EXCERPTS FROM FCC REGULATIONS

FCC regulations state that:

1. Radio transmitters may be tuned or adjusted only by persons holding a 1st or 2nd class commercial radiotelephone operator's license or by personnel working under their immediate supervision.
2. The rf power output of a radio transmitter shall be no more than that required for satisfactory technical operation considering the area to be covered and the local conditions.
3. Frequency and deviation of a transmitter must be checked before it is placed in service and rechecked once each year thereafter.

TEST EQUIPMENT REQUIRED

1. Motorola NLN6689A Alignment Tool (supplied) or equivalent.
2. Motorola DC Multimeter with rf probe or equivalent.
3. RF Wattmeter (50-ohm impedance).
4. Motorola TEK-23 Power Supply or equivalent.
5. Motorola Model T1130A Series FM Station Monitor or equivalent.
6. Motorola TEK-1A Transistorized Tone Oscillator or equivalent.
7. Motorola T1014B Precision Wide Band Oscilloscope or Model T1015A General Purpose Oscilloscope or equivalent.
8. Motorola NKD6001A Tune-up Cable.
9. Ammeter (0-0.5 amp scale).

NOMINAL VOLTAGE READINGS

NOTE
The following readings apply to a fully tuned transmitter with 15.0 v dc input.

METER POINT	M11	M12	M13
READING (VDC)	+10.[illegible]	+2.5	+0.1

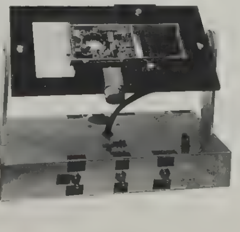
PRELIMINARY SET-UP FOR TRANSMITTER ALIGNMENT

1. Place the unit face down in the test jig and remove the back cover from the radiophone.
2. For complete alignment, the battery should be removed and a 15.0 volt dc power supply and ammeter connected to the dummy battery of the test jig. All tuning slugs except L101 (and L201 for two-frequency) should be unscrewed so that they are flush with the printed circuit board.
3. Connect a wattmeter to the antenna contact using the test cable.

FREQUENCY CALCULATIONS

$f_o = \frac{f_c}{9}$ where: f_o = oscillator frequency and f_c = carrier frequency

> ***NOTE***
> The NKD6001A Tune-up Cable must be used when aligning transmitter into a 50 ohm wattmeter in order to simulate the actual impedance of the antenna. Reduced radiated power will result if the radio is tuned directly into the wattmeter without the tune-up cable.



Radio Set
In Test Jig

Transmitter Metering
and Alignment Points

STEP	TEST EQUIPMENT	METER POINT	ADJUSTMENT	PROCED[illegible]
1		----	----	OSCILLATOR L101 is preset to the assigned frequency at the factory. D[illegible] readjust L101 unless the crystal is replaced or the setting was accidentally changed. [illegible] L101, s[illegible] 101 for zero reading on the monitor CARRIER FRE- [illegible] TRANSMITTER O[illegible] OSCILLATOR NO. 2: Use the same procedure as above, substituting L201 for L101.
2	----	----	----	Adjust power supply voltage for 15.
3	DC Multimeter	M11	L101 L201	NOTE: See step 1 above before performing [illegible] Tune L101 for a dip. On two-frequency models, switch to F2 and tune L201 [illegible] a dip.
4	DC Multimeter	M12	L103 L104	Tune L103 and L104 for a maximum reading. Re-[illegible] insure that a maximum has been obtained. This circuit is tuned to the [illegible] crystal frequen[illegible]
5	DC Multimeter	M12	L105	Tune L105 for a dip in the meter reading. This circuit is tu[illegible] crystal frequen[illegible]
6	DC Multimeter	M13	L106	Tune L106 for a maximum negative reading
[illegible]	RF wattmeter and NKD6001A Tune-up Cable	----	L107 L109 L111 L112	Tune for maximum power output in pairs as follows: Tun[illegible] power output then L109, then repeak L107. Repeat for L111 and L112
[illegible]	RF wattmeter and NKD6001A Tune-up Cable	----	L105 L106	Repeak L105 and L106 for maximum power [illegible].
[illegible]	RF wattmeter and NKD6001A Tune-up Cable	----	L107 L109 L111 L112	Repeak L107 and L109 for maximum power output, then repeat using L111 and L112
1[illegible]	RF wattmeter, Ammeter and NKD6001A Tune-up Cable	----	L112	Tune L112 until the current drain decreases to a [illegible] point is reached, adjust L112 until the total current drain is slightly above th[illegible] minimum obtained in the dip and the power output is above that which occurs a[illegible] the current dip. NOTE: If a current dip cannot be obtained, tune L112 until th[illegible] current decreases and the power output is about 2.25 watts
1[illegible]	RF wattmeter	----	L111	Tune L111 into the board until the power output is about 2.0 watts.
[illegible]2	RF wattmeter and Ammeter	----	L109 L107	Tune L109 out of the board until the current drain decreases to about 330 ma Then tune L107 for maximum power output and minimum current [illegible].
1[illegible]	RF wattmeter and Ammeter	----	L111 L112	Tune L112 and L111 for best power output and minimum current drain as follows First increase the power output by tuning L112, [illegible] power output is obtained. If the current drain is greater than 310 ma, r[illegible] L112 and then tun[illegible]. ***NOTE*** It may be necessary to readjust L109 while adjusting L111 and L112 for rated power output at the 310 ma current drain spe[illegible] TWO-FREQUENCY TRAN[illegible] S[illegible]ch between F1 and F2 while t[illegible]ng L107 [illegible] frequency separa[illegible] 1.0 MHz or less. [illegible] if the frequency separation is between 1.[illegible]
[illegible]4	--	----	-	DEVIATION CHECK See IDC ADJUSTMENT procedure on the reverse side of this cha[illegible] adjusting the IDC control. (R11[illegible])

Figure 67. Transmitter Alignment Procedure

cy Models:

eviation of the F1 channel as indicated in the preceding steps.

e deviation of the F2 channel.

tting the deviation on two-frequency transmitters, always adjust the IDC control on
ency which produces the highest deviation. Then, when the deviation is checked on
frequency, it should be no less than ±4.5 kHz and no more than ±5.0 kHz.

SUREMENT OF DEVIATION

scillator is not available, a loud sustained whistle of approximately 1000 Hz can
gh measurement of deviation. If this rough check indicates the need for resetting
nly under controlled conditions, using a 1000 Hz tone as previously indicated. The
oscilloscope should always be performed with a steady controlled signal. Do not
te the oscilloscope with a sustained whistle as waveform distortion will prevent an
ion.

FOR MEASUREMENT OF DEVIATION

rate means of measuring transmitter deviation is to use the Motorola T1021A Port-
eter and the S1058A or S1059A Portable Test Set (with deviation meter). These units,
rmit accurate measurement and setting of transmitter deviation from a peak-reading
affected by waveform. An oscilloscope is not required. With these devices, trans-
an be measured accurately even with voice modulation.

g procedure will insure that the transmitter will comply with FCC requirements for
n.

ce of the correct deviation setting can not be overemphasized. Optimum system per-
s accurate deviation setting, both from the standpoint that overdeviation will interfere
he adjacent channel, and underdeviation may reduce system range.

Figure 68. IDC Adjustment Procedure

"IDC" ADJUSTMENT (PREFERRED METHOD USING OSCILLOSCOPE)

1. INTRODUCTION

Accuracy of test equipment is of prime importance to any user of radio communications equipment; but of equal importance is a knowledge of the characteristics of the measuring equipment under various conditions. The Motorola Model T1130A Series FM Station Monitor is the leader in the field with respect to sensitivity, accuracy under conditions of variation in rf signal level, line voltage, and other environmental conditions. In common with most other meters, however, it has the characteristic of responding differently to different wave shapes. Therefore, the use of most present-day deviation meters can lead to confusion and errors in deviation setting, if the pitfalls are unknown or disregarded.

The "ideal" deviation indicator would be one which would respond instantaneously to the peak value of the modulation deviation, regardless of waveform. The only device which meets all these requirements is an oscilloscope. It responds instantaneously, and it shows the peak value of any waveform, no matter how complex. Properly calibrated, an oscilloscope is the most accurate and reliable means for measuring and setting transmitter deviation.

The oscilloscope must be used in conjunction with a receiver which has a stable discriminator characteristic, since the oscilloscope displays the demodulated signal. In addition to the oscilloscope, a receiver and a means to accurately calibrate the system is required. The Motorola monitors fill these requirements, since they provide both a sensitive receiver with the proper discriminator characteristic and a reliable means of calibrating the oscilloscope. They have convenient terminals on the front panel for connection of the oscilloscope. Furthermore, the Motorola FM Station Monitor is provided with two modulation meter scales, 0-20 kHz for wide-band systems, and 0-10 kHz for split-channel systems.

Split-channel conversion kits are available for modification of older monitor models, so that they, too, are provided with convenient oscilloscope terminals and can be more accurate measurement devices for such systems.

2. TEST EQUIPMENT REQUIRED

a. Motorola T1130A Series FM Station Monitor or equivalent.

b. Motorola Transistorized AC Voltmeter or equivalent.

c. Motorola Model TEK-1A Transistorized Tone Generator, 1000 Hz or equivalent.

d. Motorola Model T1015A General Purpose Oscilloscope, Motorola Model T1014B Precision Wide-Band Oscilloscope or equivalent.

e. Motorola Model S1056A-9A or TU546 Series Portable Test Set (or equivalent).

3. OSCILLOSCOPE CALIBRATION

The first step in the measurement of transmitter deviation is to calibrate the oscilloscope. This can be done by using the transmitter which is to be measured.

Proceed as follows:

a. Connect the oscilloscope to the monitor oscilloscope terminals, and set up the controls in accordance with the monitor instruction manual.

b. Turn the IDC control on the transmitter chassis to the full clockwise position.

c. Feed a 1000 Hz test tone across the speaker/microphone. Modulate the transmitter with this tone so adjusted that the deviation as read on the FM monitor deviation meter is 2 kHz. An audio oscillator must be used for generation of this tone, since a sinusoidal waveform is very important. The Motorola TEK-1A Transistorized Tone Generator is excellent for this purpose.

d. Adjust the vertical gain of the oscilloscope so that the total recovered audio pattern occupies some convenient height, e.g., four small squares. See figure 1.

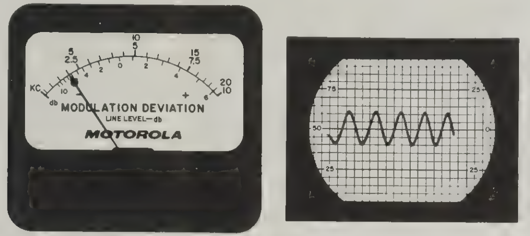


Figure 1.
Oscilloscope Calibration for
Transmitter

Having calibrated the oscilloscope, there is no further need for the modulation deviation meter and its reading should be ignored from this point on. It has already performed its important function of calibrating the oscilloscope.

With the oscilloscope calibrated as indicated, a recovered signal which occupies 10 squares (peak-to-peak) is equivalent to ±5 kHz deviation.

4. MEASUREMENT AND SETTING OF TRANSMITTER DEVIATION

a. Models for Carrier Squelch Application

Once the oscilloscope has been calibrated the transmitter deviation can be properly adjusted by the following method.

(1) Adjust the 1000 Hz input signal to 0.1 volt. This should drive the IDC circuit into full clip. See figure 2.

(2) With this input signal level adjust the IDC control on the transmitter to provide a peak-to-peak recovered signal on the oscilloscope of 10 squares, which is equivalent to ±5 kHz deviation as shown in figure 2.

(3) Reduce 1000 Hz input to 0.008 volt. No less than 3.3 kHz deviation should be observed on the oscilloscope.

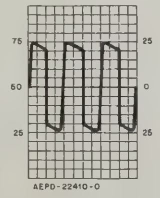


Figure 2.
5 kHz Peak Deviation as seen on the Oscilloscope
(NOTE: Waveform is clipped fully)

b. Two-Frequency Models:

(1) Adjust deviation of the F1 channel as indicated in the preceding steps.

(2) Check the deviation of the F2 channel.

(3) When setting the deviation on two-frequency transmitters, always adjust the IDC control on the frequency which produces the highest deviation. Then, when the deviation is checked on the other frequency, it should be no less than ±4.5 kHz and no more than ±5.0 kHz.

5. EMERGENCY MEASUREMENT OF DEVIATION

If an audio oscillator is not available, a loud sustained whistle of approximately 1000 Hz can be used for a rough measurement of deviation. If this rough check indicates the need for resetting deviation, do so only under controlled conditions, using a 1000 Hz tone as previously indicated. The calibration of the oscilloscope should always be performed with a steady controlled signal. Do not attempt to calibrate the oscilloscope with a sustained whistle as waveform distortion will prevent an accurate calibration.

6. OTHER MEANS FOR MEASUREMENT OF DEVIATION

Another accurate means of measuring transmitter deviation is to use the Motorola T1021A Portable Frequency Meter and the S1058A or S1059A Portable Test Set (with deviation meter). These units, properly used, permit accurate measurement and setting of transmitter deviation from a peak-reading meter which is unaffected by waveform. An oscilloscope is not required. With these devices, transmitter deviation can be measured accurately even with voice modulation.

The foregoing procedure will insure that the transmitter will comply with FCC requirements for maximum deviation.

The importance of the correct deviation setting can not be overemphasized. Optimum system performance demands accurate deviation setting, both from the standpoint that overdeviation will interfere with the user on the adjacent channel, and underdeviation may reduce system range.

Figure 68. IDC Adjustment Procedure

MOTOROLA

MODEL CHART

FOR

150.8-174 MHz "HANDIE-TALKIE"

FM RADIO SETS

CARRIER SQUELCH ONLY

CODE:

- X = ONE ITEM SUPPLIED
- / = ONE ITEM SUPPLIED, CHOICE DEPENDENT ON CARRIER FREQ.
- ◢ = ONE ITEM SUPPLIED PER 5 (OR LESS) RADIO SETS
- O = ONE ITEM SUPPLIED, CHOICE OPTIONAL
- /2 = TWO ITEMS SUPPLIED, CHOICE DEPENDENT ON MODEL

*NOTE: THESE ACCESSORY ITEMS MAY ALSO BE SUPPLIED SEPARATELY

MODEL NUMBER	NUMBER OF TRANSMITTER FREQ.	NUMBER OF RECEIVER FREQ.	TYPE OF SQUELCH	SPEAKER-MICROPHONE
H23FFN-1100A	1	1	CARRIER	INTERNAL
H23FFN-1110A	2	1	CARRIER	INTERNAL
H23FFN-1130A	2	2	CARRIER	INTERNAL

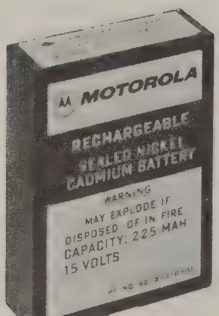
ITEM	DESCRIPTION	H23FFN-1100A	H23FFN-1110A	H23FFN-1130A
	150.8-162 MHz			
NUD6003AA	CHASSIS FRAME (ONE FREQUENCY)	/		
NUD6003AB	CHASSIS FRAME (TWO FREQUENCY)		/	/
YVSR-83	TRANSMITTER CRYSTAL	/	/2	/2
YMRX-109	RECEIVER CRYSTAL	/	/	/2
YNR	RECEIVER 1ST IF CRYSTAL (16.345 MHz)	/	/	/
	162-174 MHz			
NUD6004AA	CHASSIS FRAME (ONE FREQUENCY)	/		
NUD6004AB	CHASSIS FRAME (TWO FREQUENCY)		/	/
YVSR-83	TRANSMITTER CRYSTAL	/	/2	/2
YMRX-110	RECEIVER CRYSTAL	/	/	/2
YNR	RECEIVER 1ST IF CRYSTAL (17.545 MHz)	/	/	/
NLN6677A	BATTERY COVER	X	X	X
NLN6676A	BACK COVER	X	X	X
NLN6674A	FRONT COVER	X	X	X
*NLN6682A	NICKEL-CADMIUM BATTERY	O	O	O
*NLN6683A	MERCURY BATTERY	O	O	O
*NAD6211A	TELESCOPING ANTENNA	O	O	O
NLN6689A	TUNING TOOL	◢	◢	◢
NLN6690A	NAMEPLATE	X	X	X
NLN6786A	COIL IDENTIFICATION LABEL	X	X	X
NBN6044A	PACKING KIT	X	X	X
*NLN6686A	CARRYING CASE AND COVER	O	O	O

Figure 69.

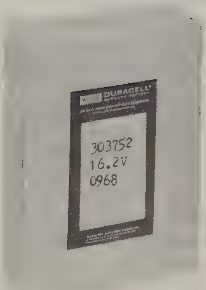
TABLE OF ACCESSORIES

MODEL NO.	NOMENCLATURE
NLN6682A	Nickel-Cadmium Battery
NLN6683A	Mercury Battery
NLN6684A	Single Unit Charger
NLN6774A	Charger Insert Conversion
NLN6685A	Multiple Unit Charger
NLN6686A	Carrying Case and Cover
NLN6687A	Lavalier and Safety Lanyard
NLN6731A	Chest Pack, Black
NAD6211A	Antenna, Telescoping
NAD6212A	Antenna, Flexible
NAD6213A	Antenna, Rigid Loop
NAD6219A NAD6220A	Antenna, Heliflex (150.8-155 MHz) Antenna, Heliflex (155-174 MHz)
NLN6691A	Vehicular Charger
NKN6139A	Antenna Input Adapter Cable
NKD6001A	Tune-Up Cable
NEN6072A	Test Fixture
NLN6795A	Carrying Case, Spare Battery
NLN6803A	Strap, Cover
NLN6675A	Back Cover, With Clip

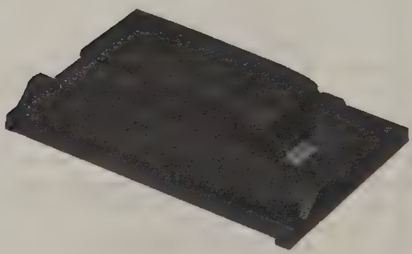
ACCESSORIES



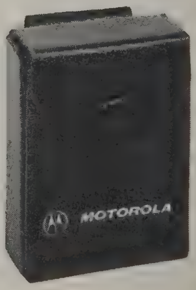
Model NLN6682A
Nickel-Cadmium
Battery



Model NLN6683A
Mercury Battery



Model NLN6675A
Back Cover, with Clip

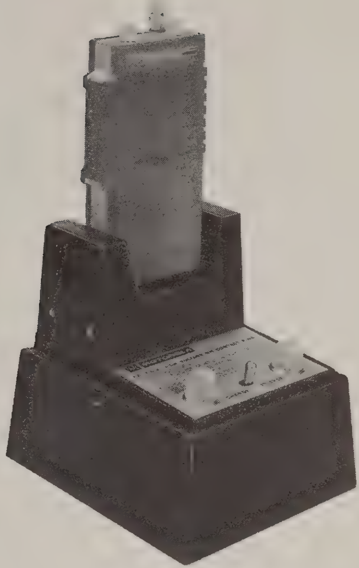


Model NLN6795A
Carrying Case,
Spare Battery

Figure 72.

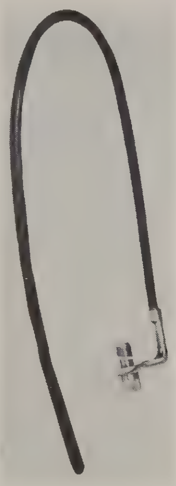
Model NLN6731A
Chest Pack (Black)

Model NLN6686A
Carrying Case and Cover

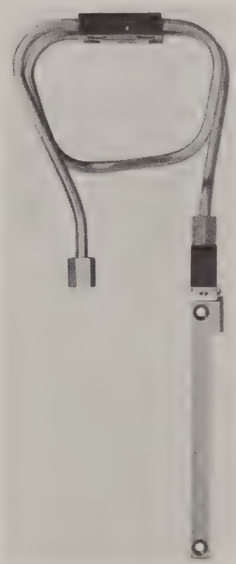


Model NLN6684A
Single Unit Charger

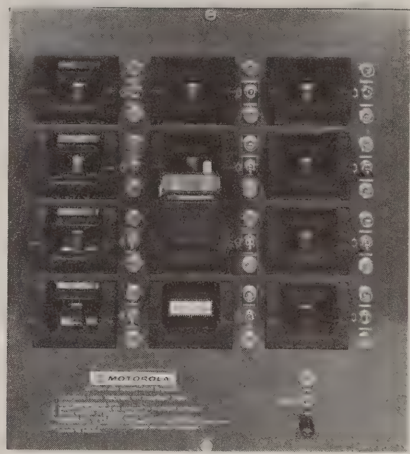
Model NAD6211A
Antenna,
Telescoping



Model NAD6212A
Antenna, Flexible

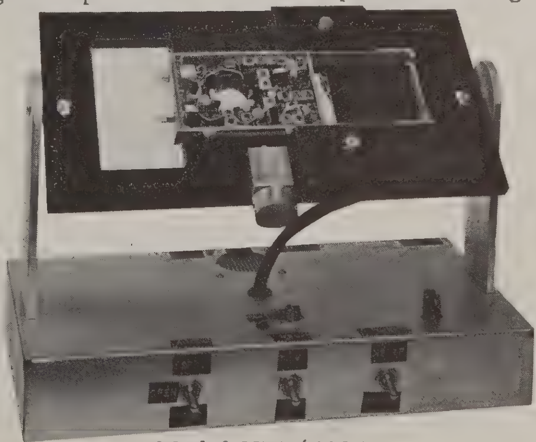


Model NAD6213A
Antenna, Rigid-loop

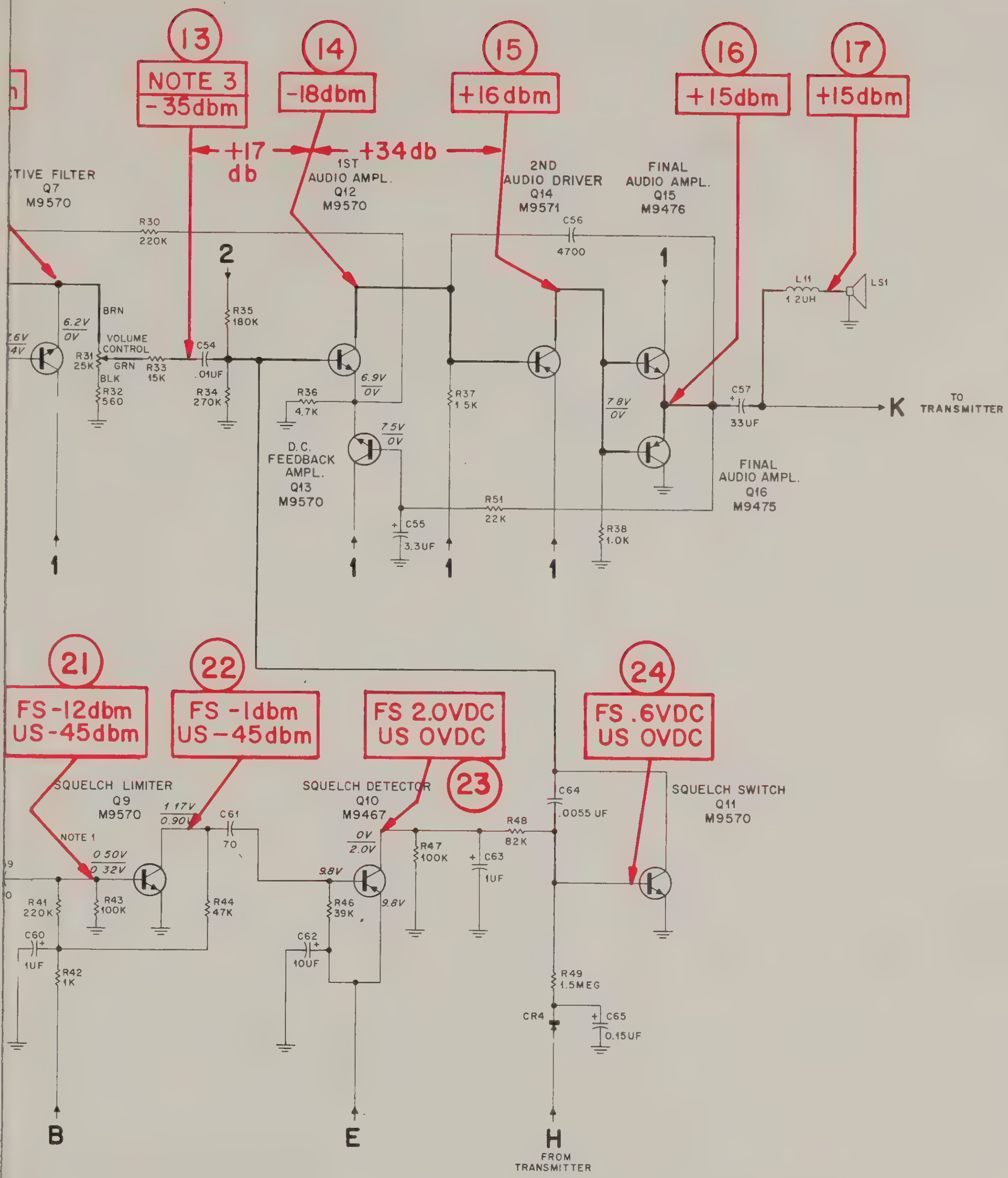


Model NLN6685A
Multiple Unit Charger

Model NLN6687A
Lavalier and Safety Lanyard



Model NEN6072A
Test Fixture



A21-0

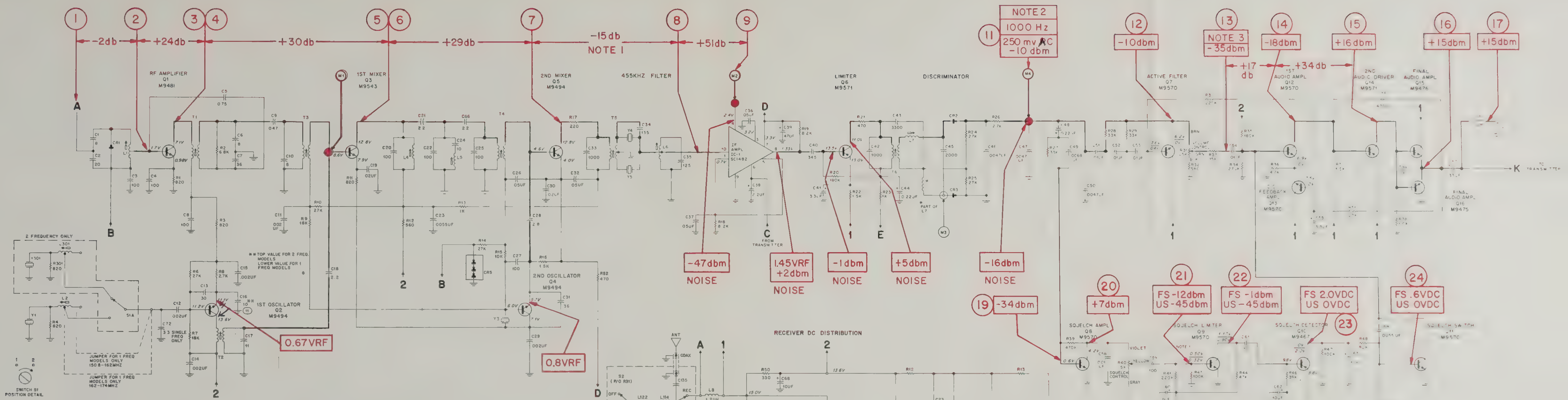
MODEL TABLE

MODEL	CHASSIS SUFFIX	FREQUENCY RANGE
NUD6003AA CHASSIS		150.8–162MHZ
NUD6004AA CHASSIS		162–174MHZ

2ND OSCILLATOR FREQUENCY TABLE

CARRIER FREQUENCY fc	2ND OSCILLATOR CRYSTAL FREQUENCY FO2
150.8–162MHZ	16.345MHZ
162–174MHZ	17.545MHZ

Figure 73.
HT 220 Receiver Schematic



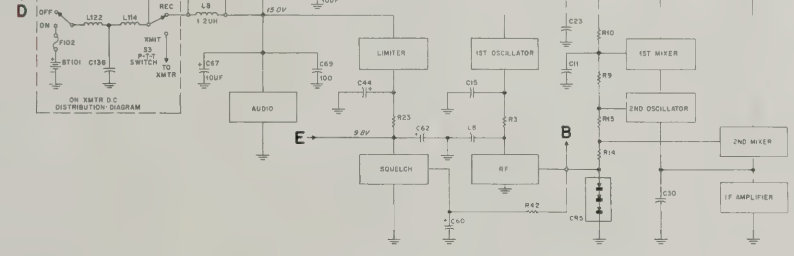


TABLE I
S1 FUNCTIONS

2 FREQUENCY STANDARD SQUELCH		
PIN	POSITION	FUNCTION
—	—	—
2	1	F1
1	2	F2
—	—	—

RECEIVER SCHEMATIC

1. FOR THIS MEASUREMENT REFER TO FIGURE 42 (RF STAGE GAIN MEASUREMENTS OF 455 KHz FILTER & I.C. 1482).
2. REFER TO AUDIO STAGE GAIN CHARTS, FIGURE 39.
3. ADJUST THE VOLUME CONTROL FOR -35 dbm.
4. FOR ADDITIONAL NOISE VOLTAGE MEASUREMENTS REFER TO FIGURE 46.

RECEIVER NOTES

5. WHERE TWO REFERENCE VOLTAGES ARE SHOWN, i.e. $\frac{10V}{12V}$, BOTTOM VALUE IS FOR SQUELCH MODE OF OPERATION, TOP VALUE IS FOR UNSQUELCHED MODE.
6. UNLESS OTHERWISE STATED, CAPACITANCES ARE IN PICO-FARADS (MMF), AND RESISTANCES ARE IN OHMS (K = 1000 OHMS).
7. DC VOLTAGES ARE MEASURED USING A MOTOROLA DC MULTIMETER, OR EQUIVALENT, AND ARE IN REFERENCE TO CHASSIS GROUND (B-).
8. LEGEND:

f_c = CARRIER FREQUENCY

f_{o1} = 1ST OSCILLATOR FREQUENCY

44.4-48.4 MHz	150.8-162 MHz
48.0-52.0 MHz	162-174 MHz

f_1 = HI IF FREQUENCY

16.8 MHz	150.8-162 MHz
18.0 MHz	162.0-174 MHz

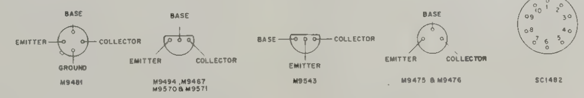
f_{o2} = 2ND OSCILLATOR FREQUENCY

16.345 MHz	150.8-162 MHz
17.545 MHz	162.0-174 MHz

f_2 = LO IF FREQUENCY

$f_c = 3f_{o1} + f_1$

TRANSISTOR DETAILS
BOTTOM VIEWS



SCHEMATIC 63E81059A21 O

MODEL TABLE

MODEL	CHASSIS SUFFIX	FREQUENCY RANGE
NUD6003AA CHASSIS		150.8-162MHZ
NUD6004AA CHASSIS		162-174MHZ

2ND OSCILLATOR FREQUENCY TABLE

CARRIER FREQUENCY fc	2ND OSCILLATOR CRYSTAL FREQUENCY FO2
150.8-162MHZ	16.345MHZ
162-174MHZ	17.545MHZ

Figure 73.
HT 220 Receiver Schematic

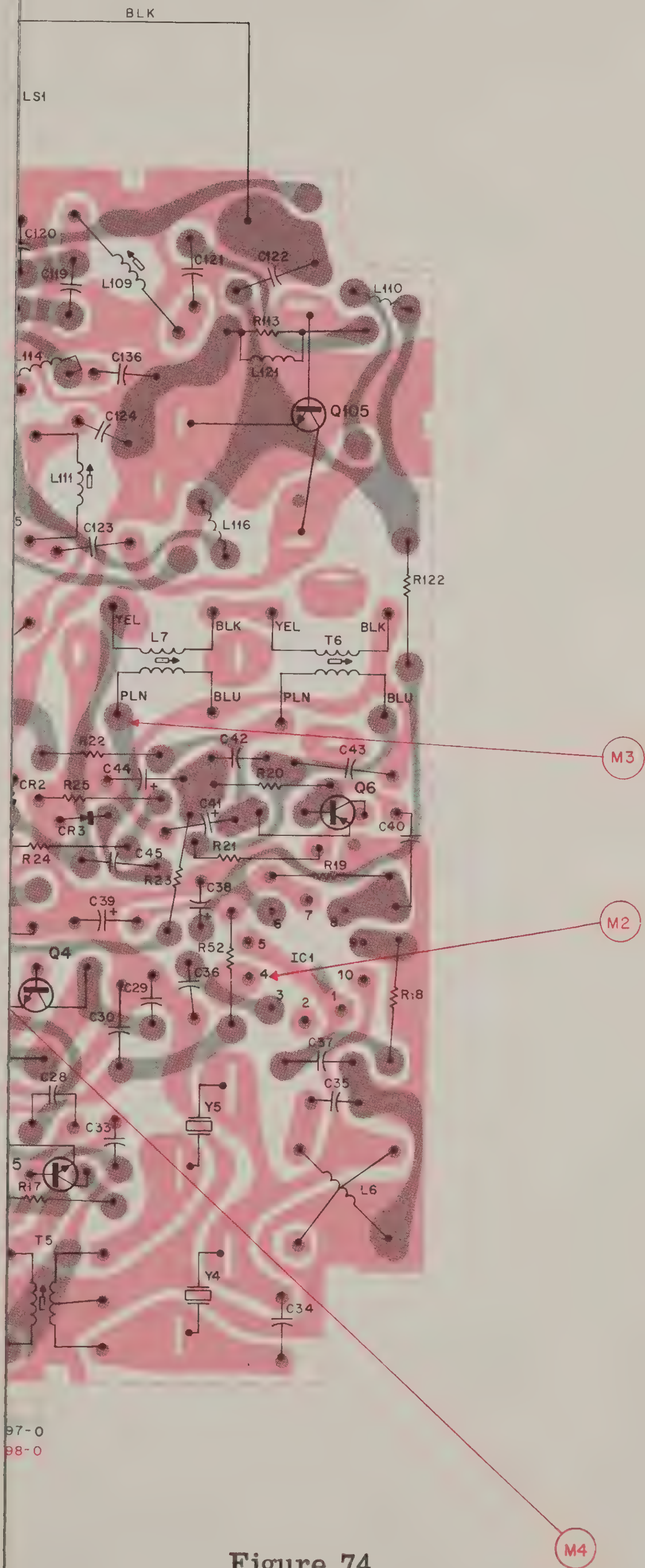
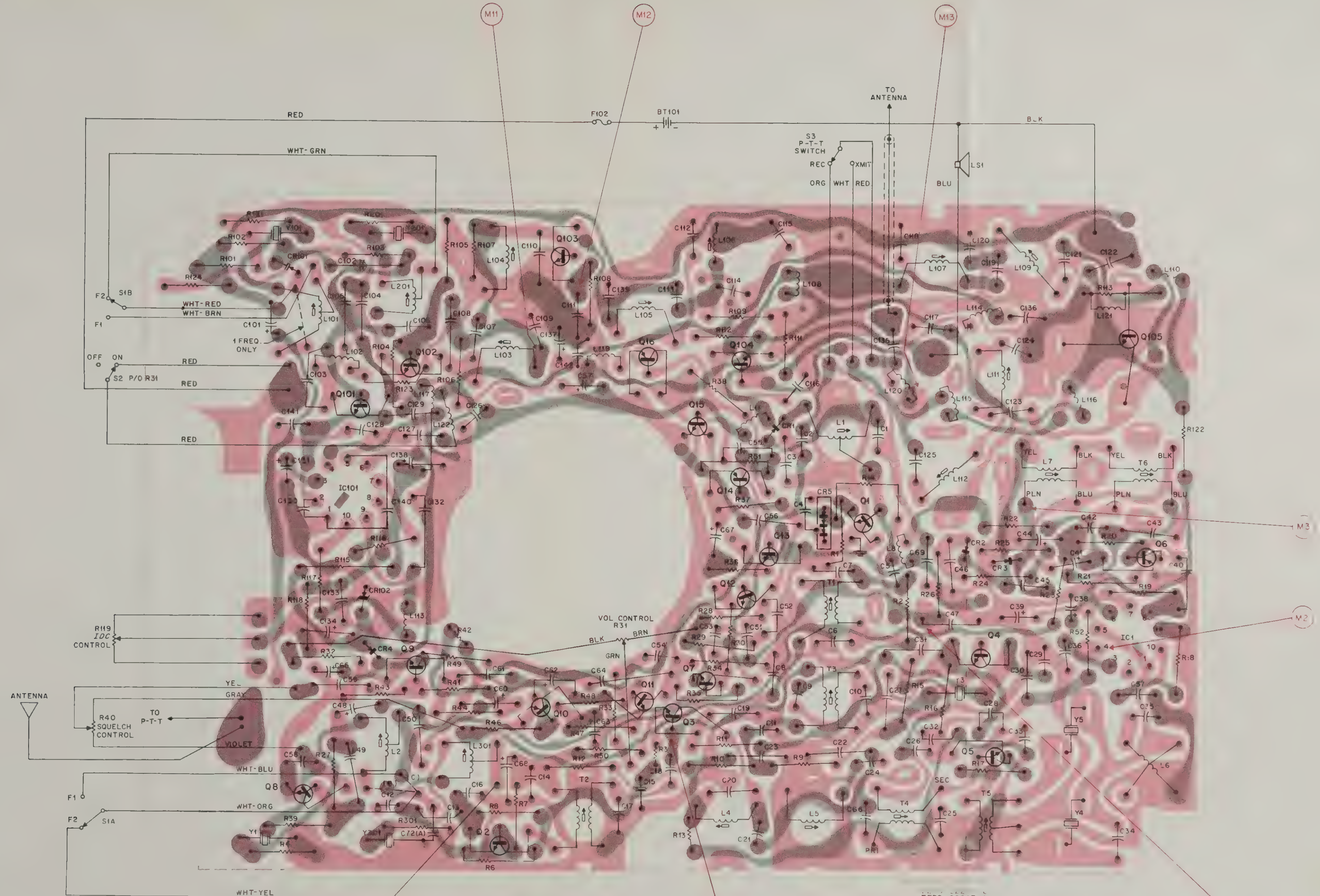


Figure 74.
Transmitter-Receiver Printed
Circuit Board Detail



(A) SINGLE FREQUENCY UNITS ONLY
(B) ONE FREQUENCY 150.8-162MHZ UNITS ONLY
(C) ONE FREQUENCY 162-174MHZ UNITS ONLY

EEPD-22097-0
EEPD-22098-0

Figure 74.
Transmitter-Receiver Printed Circuit Board Detail

R - Refer to the Receiver Stage Gain Measurement Procedures
T - Refer to the Transmitter RF stage gain chart
M - Metering Point

NOTE: Plating shown is side away from components

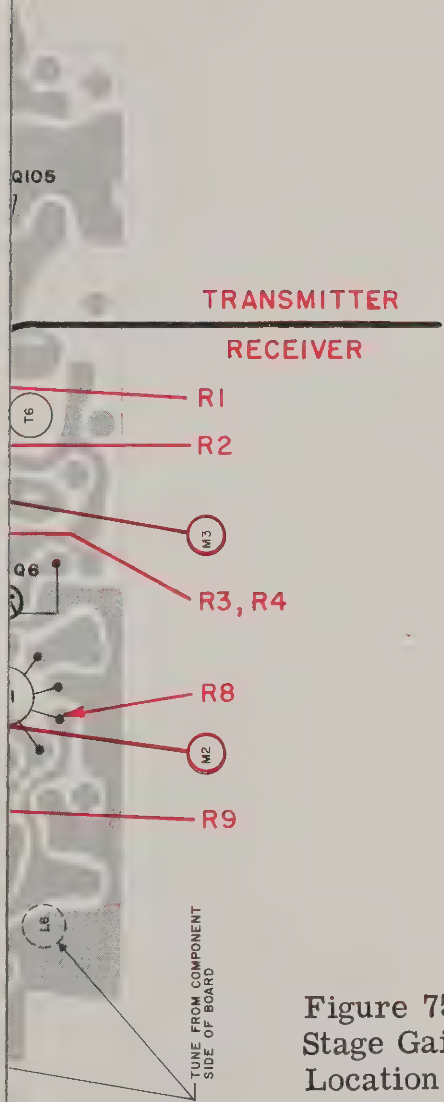
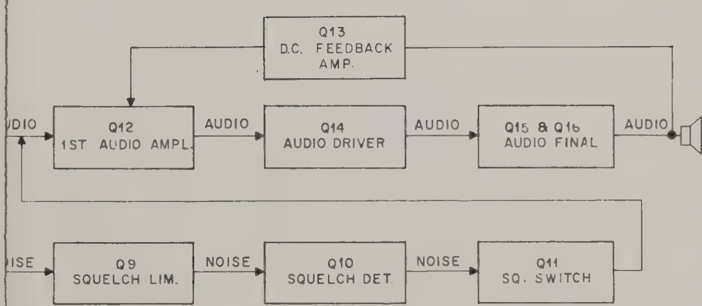


Figure 75.
Stage Gain Measurement Location Detail



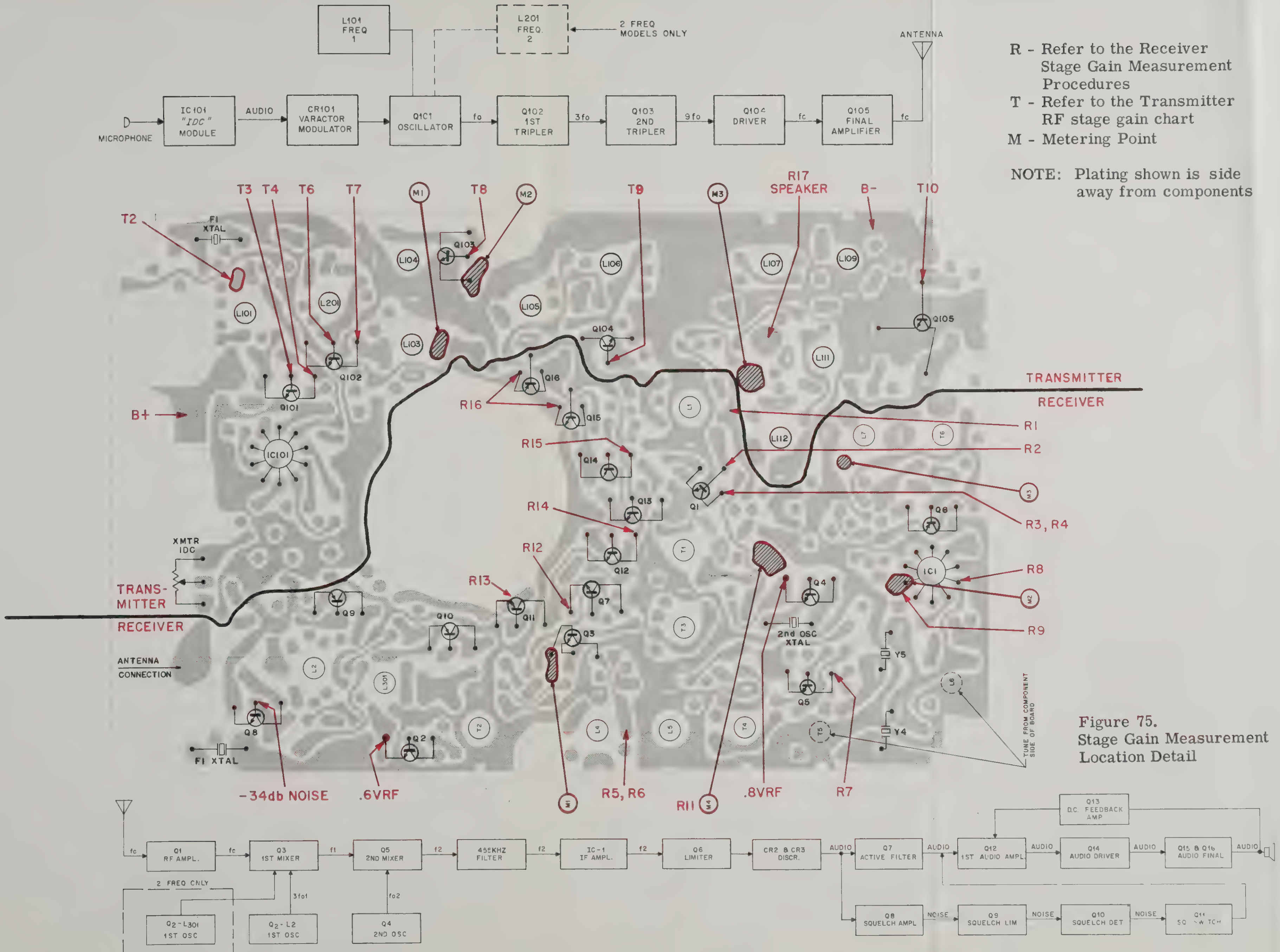


Figure 75.
Stage Gain Measurement
Location Detail

NOTE: REFER TO FIGURE 54, TRANSMITTER R.F. MEASUREMENTS FOR PROCEDURE

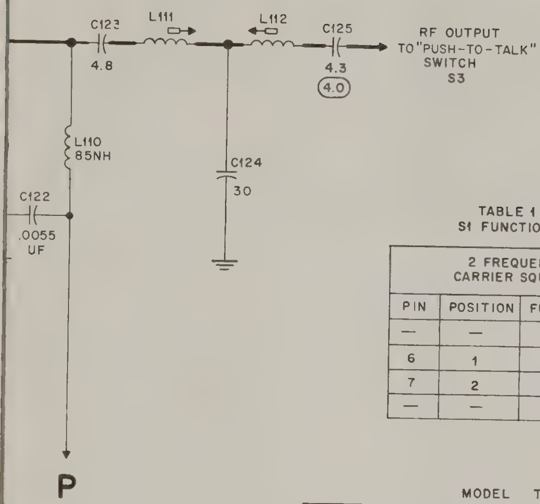


TABLE 1
S1 FUNCTIONS

2 FREQUENCY CARRIER SQUELCH		
PIN	POSITION	FUNCTION
—	—	—
6	1	F1
7	2	F2
—	—	—

MODEL TABLE

MODEL	CHASSIS SUFFIX	FREQUENCY RANGE
NUD6003AA CHASSIS		150.8 - 162 MHZ
NUD6004AA CHASSIS		162 - 174 MHZ

SWITCH S1
POSITION
DETAIL

TRANSISTOR DETAILS
BOTTOM VIEW

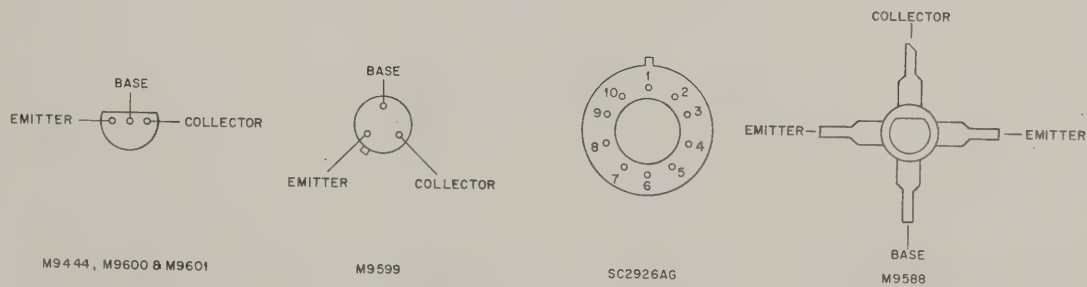


Figure 76.
HT 220 Transmitter Schematic

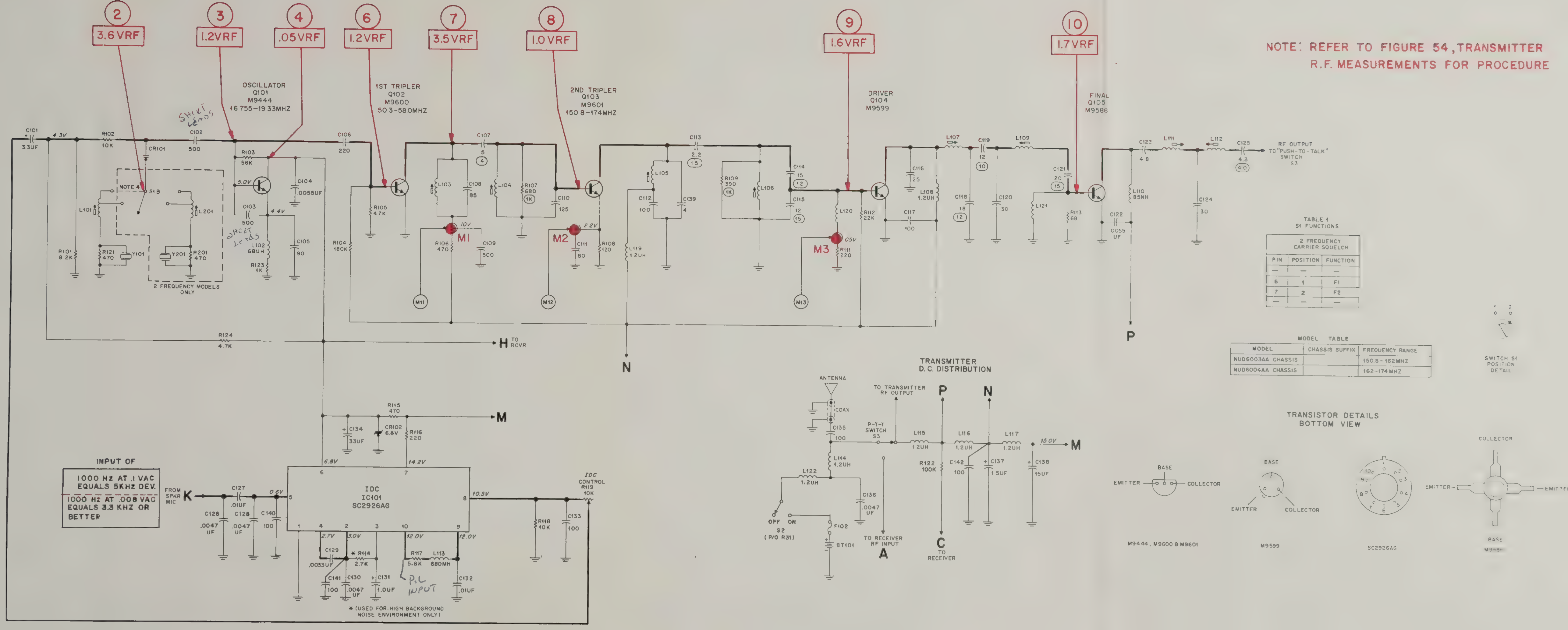


TABLE 1
S1 FUNCTIONS

2 FREQUENCY CARRIER SQUELCH		
PIN	POSITION	FUNCTION
—	—	—
6	1	F1
7	2	F2
—	—	—

MODEL TABLE

MODEL	CHASSIS SUFFIX	FREQUENCY RANGE
NUD6003AA CHASSIS		150.8 – 162 MHZ
NUD6004AA CHASSIS		162 – 174 MHZ

TRANSMITTER NOTES

1. UNLESS OTHERWISE STATED, CAPACITANCES ARE IN PICO-FARADS (MMF) AND RESISTANCES ARE IN OHMS (K = 1000 OHMS).
2. WHEN TWO VALUES ARE GIVEN FOR A COMPONENT, THE TOP VALUE IS FOR 150.8-162 MHz, THE BOTTOM VALUE IS FOR 162-174 MHz.
3. SEE TABLE 1 FOR SWITCH S1 FUNCTIONS.
4. JUMPER IS USED ONLY ON ONE-FREQUENCY MODELS.
5. DC VOLTAGES ARE TAKEN WITH A MOTOROLA DC MULTI-METER, OR EQUIVALENT, AND ARE IN REFERENCE TO CHASSIS GROUND (B-).

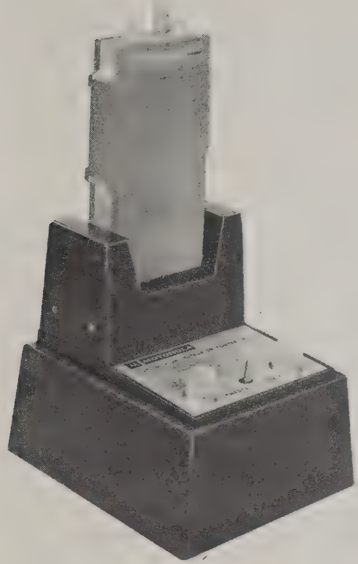
Figure 76.
HT 220 Transmitter Schematic

MOTOROLA

SINGLE UNIT

BATTERY CHARGER

MODEL NLN6684A



1. INTRODUCTION

The Model NLN6684A Single Unit Battery Charger is an accessory item for the H23FFN Series "Handie-Talkie" ® FM Radio using the nickel-cadmium battery power supply. It is approved under the manufacturer's guarantee covering the NLN6682A Nickel-Cadmium Battery Kit.

The charger will recharge the nickel-cadmium battery either in or out of the radio housing.

2. DESCRIPTION

This unit is a constant current charger (16 hour charge rate) and contains a trickle charge circuit. If a fully charged battery is to be left unattended for a long period of time, it's full charge can be maintained by placing the CHARGE-TRICKLE switch in the TRICKLE position.

This charger operates from a 105-125 volts, 50-60 Hertz source. The power transformer has a tapped primary winding which is used to correct for high or low line voltage conditions.

The unit contains charge rate lamp type #1829 (Motorola Part Number 65K810161) in the circuit and should be used with typical duty cycle requirements. With this lamp (DS2) the charger will replace the charge removed from a battery when used in a duty cycle of 5% transmit, 5% receive and 90% standby. This duty cycle represents a 30 second transmission every 10 minutes in an 8-hour day.

3. OPERATION

Place the battery charger in operation, as follows:

a. Connect the a-c line cord to a 105-125 volt, 50-60 cps source. Set the CHARGE-TRICKLE switch to TRICKLE.

NOTE

Normal operation calls for eight hours use of the battery followed by 16 hours of charge. Always return to TRICKLE after 16 hours of charging.

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68P81059A53
Issue - A

b. Place the ON-OFF switch on the radio in the OFF position.

NOTE

If monitoring is desired, the radiophone may be left in operation while being charged. This will, however, result in a reduced charging rate.

c. Insert the bottom end of the radio set with the speaker to the front, or the battery only, into the charger receptacle making sure that the battery or radiophone is seated firmly. The CHARGE lamp will light indicating that the battery is being charged.

NOTE

MAKE SURE THE LAMP GLOWS, OTHERWISE THE BATTERY IS NOT CHARGING.

d. Allow sufficient time for the battery to charge (16 hours insures a complete charge).

e. If the battery is to be charged for periods exceeding 16 hours, the CHARGE-TRICKLE switch must be set to TRICKLE.

WARNING

Do not discard batteries in fire as they may explode.

4. MAINTENANCE

a. Fuse

If the charger does not operate, check the fuse. Replace it if necessary. If the replaced fuse "blows", check the transformer secondary and rectifier for a short circuit. A short circuit existing across the contact pins of the charger receptacle will not cause the fuse to "blow".

b. High and Low Line Voltage Adjustment

Check the a-c line voltage to the charger. If the line voltage is above 125 volts, remove power from the charger. Remove the line cord lead from the GRN-BLK transformer lead on the terminal board and connect it to the RED-BLK transformer lead.

If the line voltage is below 105 volts, remove the line cord lead from the GRN-BLK lead on the terminal board and connect it to the YEL-BLK transformer lead.

c. Charging Current

To check the charging current at the charger receptacle, place a 0-120 ma meter across the terminal lugs connected to the back of the contact pins of the charger receptacle. With 117 volts a-c applied to the charger, the reading on the meter should be approximately 38 ma with the #1829 lamp. The CHARGE lamp should light when the meter is connected.

d. Trickle Current

To check the trickle current at the charger receptacle, place a 0-12 ma meter across the terminal lugs connected to the back of the contact pins of the charger receptacle. With 117 volts a-c applied to the charger, the reading on the meter should be approximately 3 ma. The TRICKLE lamp should light when the meter is connected.

e. Contact Pins

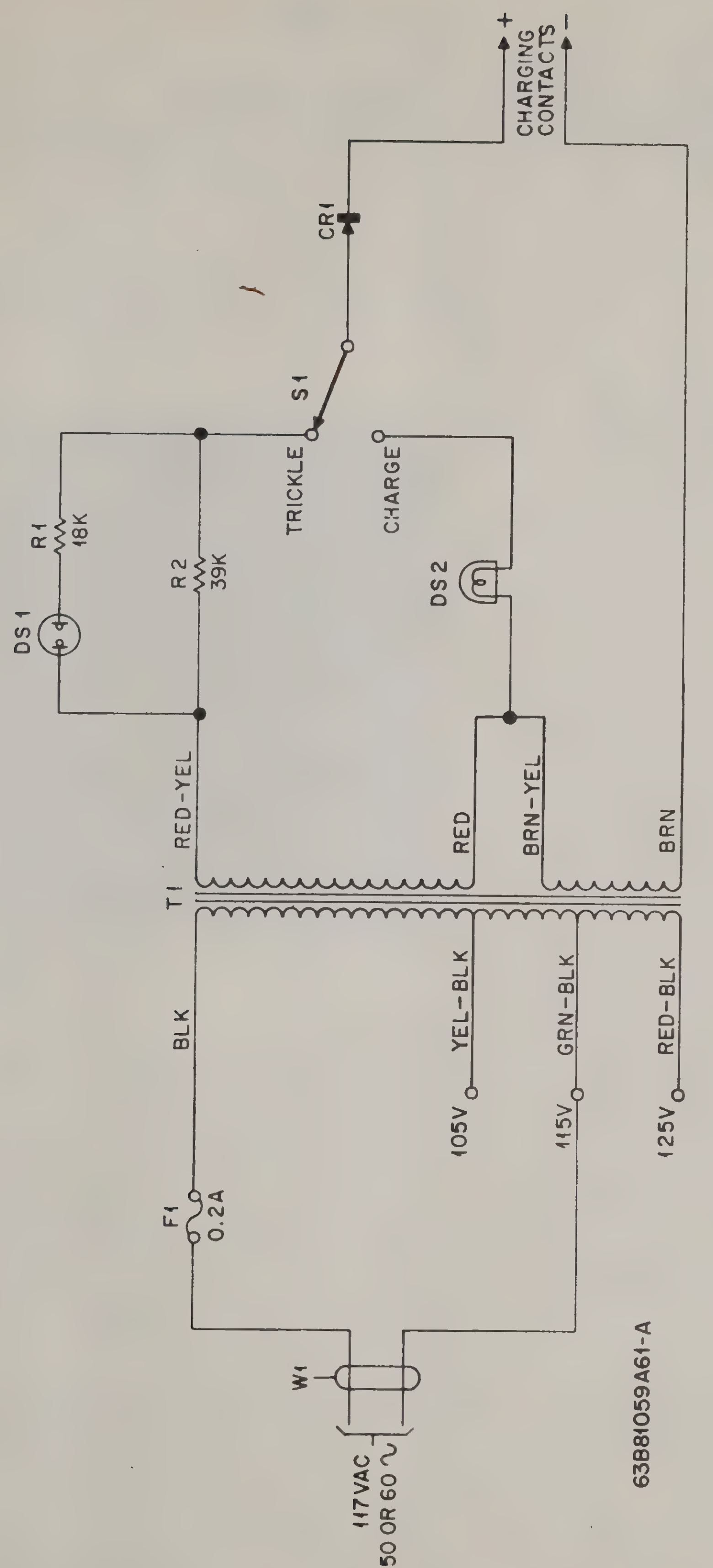
WARNING

HIGH VOLTAGE exists across the contact pins of the charging receptacle when the unit is in TRICKLE operation. Be sure that the charger is disconnected from the a-c line supply voltage before attempting to do any work on these contact pins.

If the unit has the correct output current, but neither lamp lights when the radio is placed in it, check the contact pins of the radio and charger for dirt and grease or other material which may prevent the pins of the radio from making good contact with the pins of the charger receptacle.

NOTE

The radio set incorporates a safety feature to prevent charging mercury batteries. Therefore, if a mercury battery equipped radio set is placed in the charger, neither lamp will light.



PREVIOUS REVISIONS AND PARTS LIST
SHOWN ON BACK OF THIS DIAGRAM

Single Unit Battery Charger
Schematic Diagram
Motorola No. 63B81059A61-A
2/13/69-UP

REVISIONS

DIAG. ISSUE	CHASSIS AND SUFFIX NO.	REF. SYMBOL	CHANGE	LOCATION
A	NLN6684A	DS2	WAS 15K81061	PARTS LIST
			ADDED 1V80787A27 HOUSING AND CONTACT ASSEMBLY	NON-REFERENCED ITEMS

PARTS LIST

NLN6684A Battery Charger EPD-21905-A

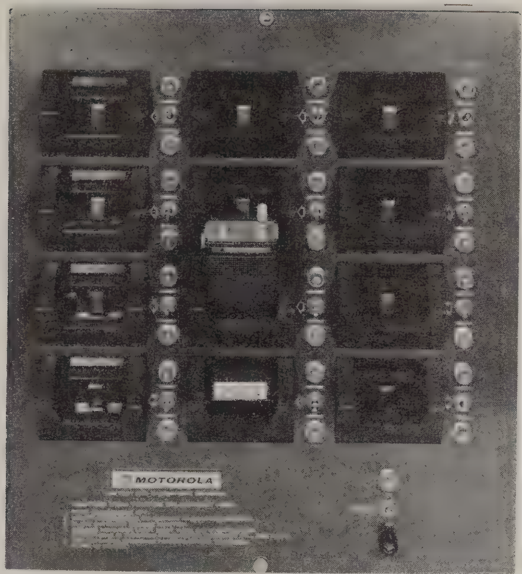
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		SEMICONDUCTOR DEVICE, diode: (NOTE)
CR1	48C82466H14	silicon
		LAMP, glow:
DS1	65K818438	neon; NE51-H
		LAMP, incandescent:
DS2	65K810161	28 v; 70 ma; min. bay base; type #1829
		FUSE, cartridge:
F1	65K480555	0.2 a; 125 v
		RESISTOR, fixed: ±10%; 1/2 w;
R1	6R5591	18K
R2	6R6487	39K
		SWITCH, toggle:
S1	40A80248	spdt
		TRANSFORMER, power: 50/60 Hz :
T1	25C82228E01	pri: BLK (common) YEL-BLK (105 v tap) GRN-BLK (115 v tap) RED-BLK (125 v) (full winding); res 100 ±10% sec: (h. v.); RED, RED-YEL; res 290 ±10% sec: (l. v.); BRN, BRN-YEL; res 30 ±10%
		CABLE ASSEMBLY, power:
W1	30C865903	3 conductor; rubber covered: each conductor No. 18 str; incl 3 contact male plug
		LAMPHOLDER:
XDS1, 2	60K17135	single contact; min. bay.; does not include the following parts: 14K18684 WASHER, insulating 43K859511 BUSHING, mounting 60A898914 LENS, fluted; clear
		FUSEHOLDER:
XF1	9C82083C02	single fuse mounting: extractor post type
	NON-REFERENCED ITEMS	
	31S124667	3 solder lug terminals (No. 1, 2, 3) plus mounting lug (No. 4)
	31R121255	3 solder lug terminals (No. 2, 3, 4) plus mounting lug (No. 1)
	42B82018H05	RETAINER, cable
	1V80787A27	HOUSING and CONTACT assy. incl 1V80789A26 HOUSING 41A82093A02 SPRING, compression; 3 req'd 29S132531 LUG, solder; 3 req'd 4A82094A01 WASHER, special, 6 req'd 3S2902 SCREW, machine #2-56 x 3/16" 3 req'd 39A82092A04 CONTACT; 3 req'd 14B82296E01 INSULATOR, slide 2 req'd 64B83648H01 PLATE, cover; 2 req'd 41A83572H01 SPRING, concial 2 req'd 3S136554 SCREW, tapping #2 x 1/4"; 8 req'd

NOTE:
Replacement of diodes must be ordered by Motorola part number only for optimum performance.

MOTOROLA

MULTIPLE UNIT
BATTERY CHARGER

MODEL NLN6685A



1. INTRODUCTION

The Model NLN6685A Multiple Unit Battery Charger is an accessory item for the H23FFN Series "Handie-Talkie" ® FM Radios using the nickel-cadmium battery power supply. This unit will charge up to 12 batteries at one time. NLN6682A Batteries used in H23FFN Series radios can be charged while in or out of the radios. Each battery receptacle has a TRICKLE-CHARGE switch for individual control. The charger may be mounted on a wall, mounted on a 19-inch rack, or placed on a table or desk.

The charger is approved under the manufacturer's guarantee covering the NLN6682A Nickel-Cadmium Battery Kits.

2. APPLICATION

This unit is a constant current charger (16 hour charge rate) and contains a trickle charge circuit. If a fully charged battery is to be left unattended for a long period of time, it's full charge can be maintained by placing the CHARGE-TRICKLE switch in the TRICKLE position.

This charger operates from a 105-125 volts, 50-60 Hertz source. The power transformer has a tapped primary winding which is used to correct for high or low line voltage conditions.

The unit contains charge rate lamp type #1829 (Motorola Part Number 65K810161) in the circuit and should be used with typical duty cycle requirements. With this lamp (DS2) the charger will replace the charge removed from a battery when used in a duty cycle of 5% transmit, 5% receive and 90% standby. This duty cycle represents a 30 second transmission every 10 minutes in an 8-hour day.

3. INSTALLATION

a. Horizontal Position

The unit is shipped from the factory completely assembled and ready for use. No mounting required.

b. Vertical Position

Refer to Vertical Installation Detail.

(1) Position the supports packed with the unit as shown in the detail.

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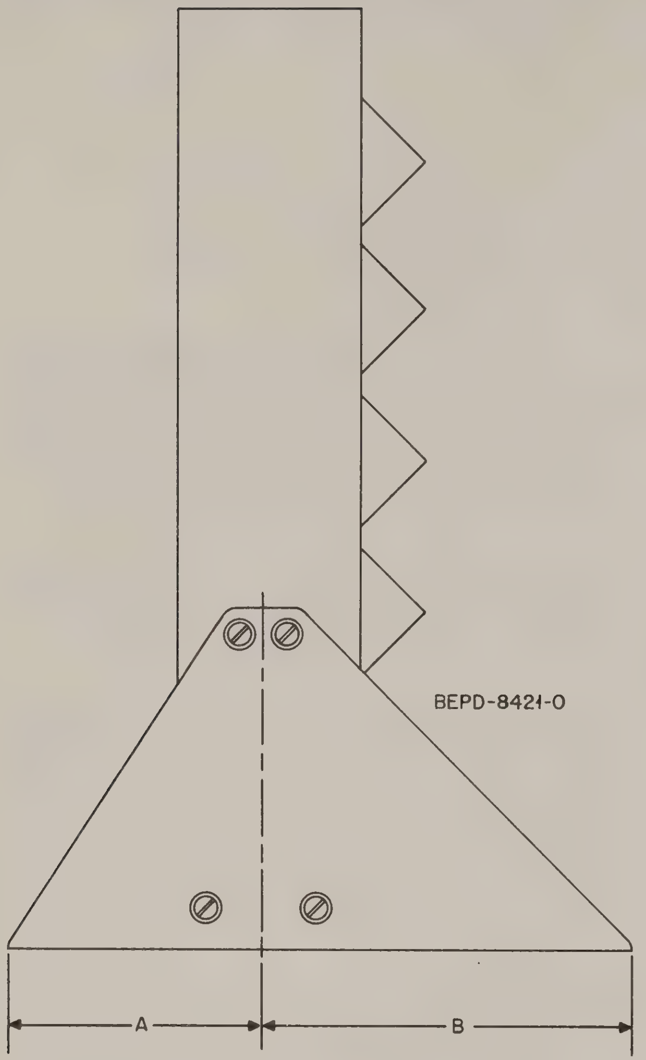


Vertical Installation Detail

(2) Using the 8 screws and washers supplied, fasten the supports to the housing.

c. Wall Installation

(1) Remove the 10 screws and washers holding the front panel to the housing and carefully lift out the panel.

(2) Pull the line cord through the opening in the housing.

(3) Remove the rubber grommet.

(4) Determine the most convenient location for the ac line cord to protrude.

(5) Remove the "knock-out" nearest the desired location and install grommet.

(6) Remove the #4 screws and rubber mounts from the rear of the housing.

(7) Using the four wood screws supplied, mount the housing to the wall.

NOTE

Mounting holes in housing are 16 inches apart for convenience in mounting to wall studs.

(8) Feed the ac line cord through the desired hole and replace the front panel.

d. Closed Rack Installation

(1) Remove the 10 screws and washers holding the front panel to the housing and carefully lift out the panel.

(2) Pull the line cord through the opening in the housing.

(3) Mount the front panel in the desired location on the rack.

e. Open Rack Installation

(1) Remove the 10 screws and washers holding the front panel to the housing and carefully lift out the panel.

(2) Pull the line cord through the opening in the housing.

(3) Mount the housing in the desired location on the rack.

(4) Feed the ac line cord through the desired hole and replace the front panel.

4. OPERATION

Place the battery charger in operation as follows:

a. Connect the ac line cord to a 110-120 volt, 50-60 cps source.

b. Set the CHARGE-TRICKLE switch of the receptacle(s) to be used to TRICKLE.

NOTE

Normal operation is for eight hours use of the battery followed by 16 hours of

NOTE (CONTD.)

charge. Always return to TRICKLE after 16 hours of charging.

c. Place the ON-OFF switch of the charger in the ON position. The lamp immediately above the switch should light, indicating the charger is in operation.

d. To charge the batteries of H23FFN Series radios while in the radio:

(1) Place the ON-OFF switch on the radio in the OFF position.

(2) Insert the bottom end of the radio, with the speaker toward the front, into the charger receptacle making sure that the radio is seated firmly. The CHARGE lamp will light to indicate that the battery is being charged.

NOTE

If monitoring is desired, the radio may be left in operation while being charged. This will, however, result in a reduced charging rate. Do not monitor while charger is in TRICKLE position.

e. To charge batteries removed from the radio: Refer to the label on the battery for proper positioning and make sure that battery is firmly seated in the charger. The CHARGE lamp will light to indicate that the battery is being charged.

NOTE

MAKE SURE THE CHARGE LAMP GLOWS WHEN THE SWITCH IS IN THE "CHARGE" POSITION, OTHERWISE THE BATTERY IS NOT CHARGING. CHECK FOR BURNED OUT BULB IF NECESSARY.

f. Allow sufficient time for the battery to charge (16 hours insures a complete charge).

g. If the battery is to be left on charge for periods exceeding 16 hours, the CHARGE-TRICKLE switch should be set to TRICKLE. The TRICKLE lamp should light indicating that the battery is charging.

NOTE

WITH THE SWITCH IN THE "TRICKLE" POSITION AND THE TRICKLE LAMP BURNED OUT, THE BATTERY WILL CHARGE AT A REDUCED RATE.

WARNING

Do not discard batteries in fire as they may explode.

5. MAINTENANCE

a. Fuse

If the charger does not operate, check the fuse. Replace it if necessary. If the replaced fuse "blows", check the transformer secondary and rectifier for a short circuit. A short circuit existing across the contact pins of the charger receptacles will not cause the fuse to "blow".

b. High and Low Line Voltage Adjustment

Check the ac line voltage to the charger. If the line voltage is above 120 volts, remove power from the charger. Remove the line cord lead from the GRN-BLK transformer lead on the terminal board and connect it to the RED-BLK transformer lead.

If the line voltage is below 110 volts, remove the line cord lead from the GRN-BLK lead on the terminal board and connect it to the YEL-BLK transformer lead.

c. Charging Current

(1) To check the charging current at a charger receptacle, place a 0-120 ma meter across the terminal lugs connected to the back of the contact pins of the charger receptacle (no battery in receptacle). With 117 volts ac applied to the charger, the reading on the meter should be approximately 38 ma. The CHARGE lamp should light when the meter is connected.

d. Trickle Current

To check the trickle current at a charger receptacle (no battery in receptacle), place a 0-12 ma meter across the terminal lugs connected to the back of the contact pins of the charger receptacle. With 117 volts ac applied to the

charger, the reading on the meter should be approximately 3 ma. The TRICKLE lamp should light when the meter is connected.

e. Contact Pins

WARNING

HIGH VOLTAGE exists across the contact pins of the charging receptacle when a unit is in TRICKLE operation. Be sure that the charger is disconnected from the ac line supply voltage before attempting to do any work on these contact pins.

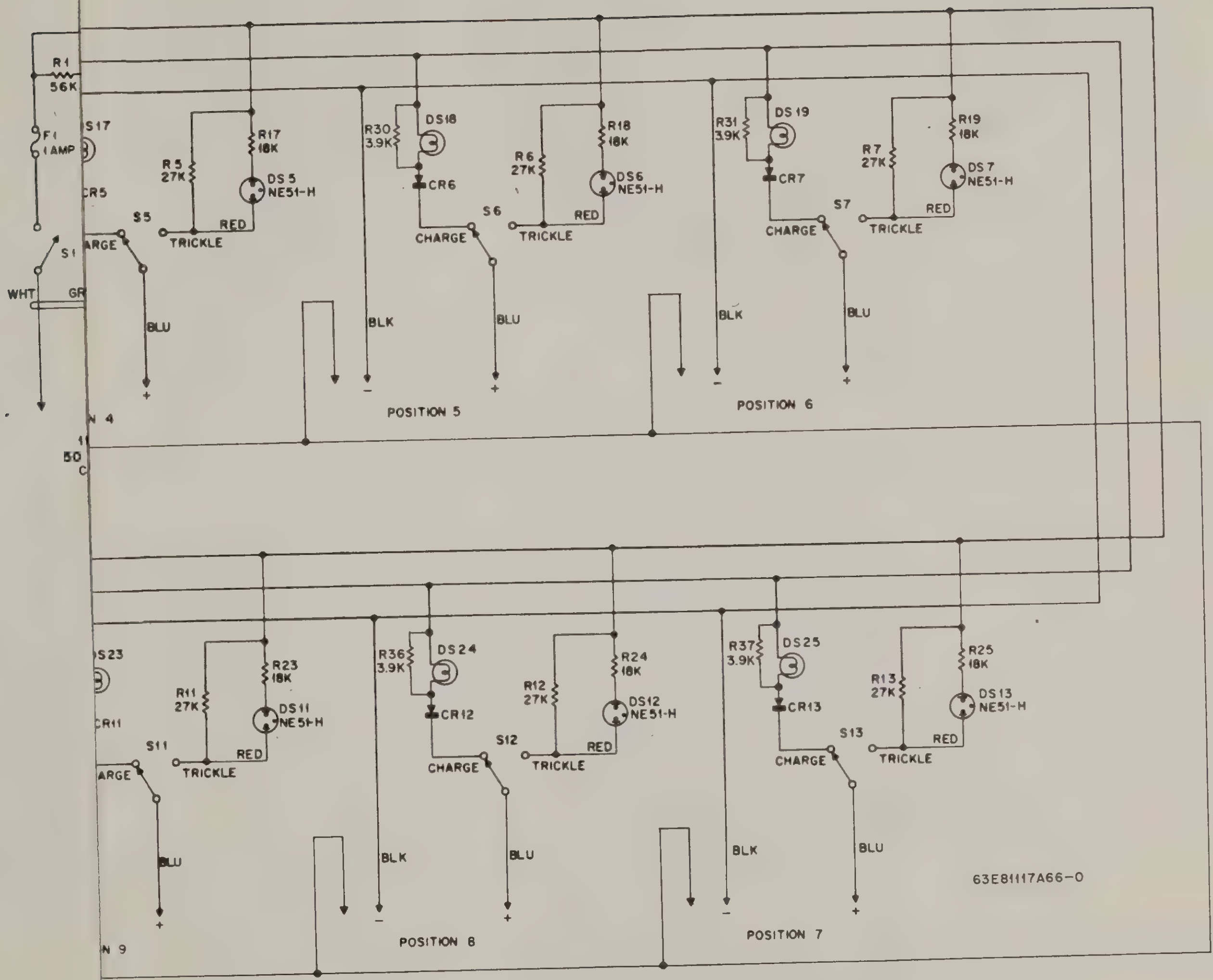
If a unit has the correct output current, but neither lamp lights when a battery or radio is placed in it, check the contacts of the radio or battery and charger for dirt and grease or other material which may prevent good contact.

NOTE

The radio incorporates a safety feature to prevent charging mercury batteries. Therefore, if a mercury battery equipped radio is placed in the charger, neither lamp will light.

6. DATA INCLUDED

Schematic Diagram	63E81117A66



PARTS LIST SHOWN ON
BACK OF THIS DIAGRAM

Multiple Unit Battery Charger
Schematic Diagram
Motorola No. 63E81117A66-O
1/13/69-GM

charger, the reading on the meter should be approximately 3 ma. The TRICKLE lamp should light when the meter is connected.

e. Contact Pins

WARNING

HIGH VOLTAGE exists across the contact pins of the charging receptacle when a unit is in TRICKLE operation. Be sure that the charger is disconnected from the ac line supply voltage before attempting to do any work on these contact pins.

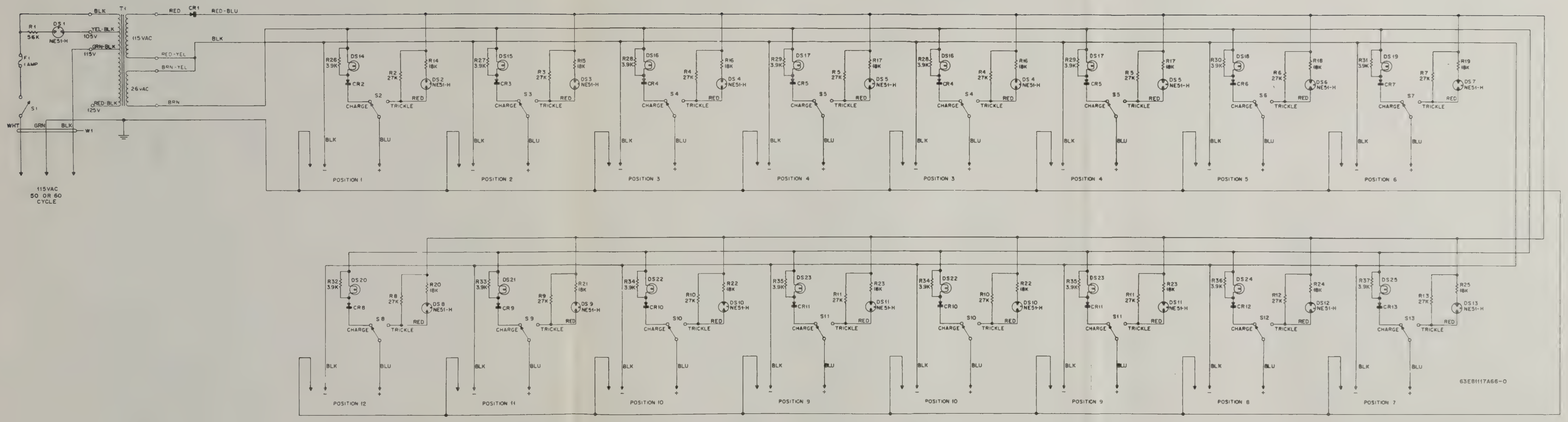
If a unit has the correct output current, but neither lamp lights when a battery or radio is placed in it, check the contacts of the radio or battery and charger for dirt and grease or other material which may prevent good contact.

NOTE

The radio incorporates a safety feature to prevent charging mercury batteries. Therefore, if a mercury battery equipped radio is placed in the charger, neither lamp will light.

6. DATA INCLUDED

Schematic Diagram	63E81117A66



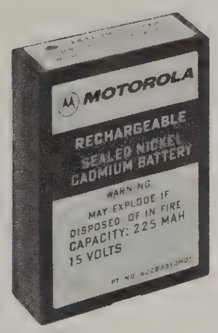
PARTS LIST SHOWN ON
BACK OF THIS DIAGRAM

Multiple Unit Battery Charger
Schematic Diagram
Motorola No. 63E81117A66-O
1/13/69 GM

MOTOROLA

NICKEL-CADMIUM BATTERY KIT

MODEL NLN6682A



1. INTRODUCTION

The Model NLN6682A Nickel-Cadmium Battery Kit is a rechargeable power source for the H23FFN Series "Handie-Talkie" ® FM Radio.

The battery consists of 12 hermetically sealed cells connected in series to provide a nominal 15.6 volt output. The cells are enclosed in a molded plastic case.

2. CHARACTERISTICS

The voltage of a nickel-cadmium battery remains approximately constant under load until the battery approaches the discharged condition. At this time, a marked decrease in this voltage occurs and the discharged condition (0.92 v per cell) is reached abruptly. Metering to determine the state of charge of this type of battery is difficult and is not normally performed. A general characteristic of all rechargeable batteries in storage is self discharge. If the battery is used after unknown periods of storage, it is recommended that it be charged for 16 hours using a Model NLN6684A or NLN6685A Battery Charger.

CAUTION

Avoid accidental short circuits. Sustained high rate discharges will damage the battery.

3. MAINTENANCE

The battery cells will never require addition of electrolyte. The only maintenance required is recharging the battery and keeping the contacts clean.

The Motorola Model NLN6684A or NLN-6685A Battery Charger is recommended for charging this battery. The use of other chargers, unless approved, will void the battery guarantee and may result in permanent damage to the battery. Follow the charging instructions which accompany the charger.

WARNING

Do not discard batteries in fire as they may explode.

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PARTS LIST

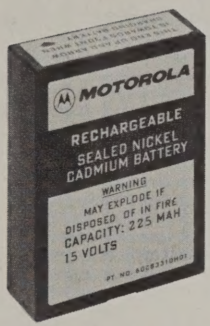
NLN6685A Multiple Unit Battery Charger EPD-21904-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		SEMICONDUCTOR DEVICE, diode:
CR1	48C82466H14	silicon
CR2 thru 13	48C82466H03	silicon
		LAMP, glow:
DS1 thru 13	65K818438	neon; NE51-H
		LAMP, incandescent:
DS14 thru 25	65K810161	28 v; 70 ma; #1829
		FUSE, cartridge:
F1	65K804910	1 amp; 125 v; slow-blow type
		RESISTOR, fixed: ±10%; 1/2 w unl stated
R1	6S6378	56K
R2 thru 13	6S6434	27K
R14 thru 25	6S5591	18K
R26 thru 37	6S129232	3.9K; 1/4 w
		SWITCH, toggle:
S1	40A482097	spst
S2 thru 13	40A80248	spdt
		TRANSFORMER
T1	25C82778E01	50/60 cycle; c/o; pri. #1: BLK, RED-BLK; 125 v ac; res. 4.9 ohms pri. #2: BLK, GRN-BLK; 115 v ac pri. #3: BLK, YEL-BLK; 105 v ac sec. #1: RED, RED-YEL; 125 v ac; res. 29 ohms sec. #2: BRN, BRN-YEL; 26 v ac; res. 0.7 ohms
		CORD, ac line:
W1	30C865903	3 conductor; #18 ga.; incl. male; 3 cont. molded plug
		LAMPHOLDER
XDS1 thru 25	60K17135	single contact; min. bay base; does not incl. 14K18684 WASHER, insulator 43K859511, BUSHING, reducer 60A89814, LENS, clear
		FUSEHOLDER:
XF1	9C82083C02	extractor post type; incl. mtg., hdwe.
	NON-REFERENCED ITEMS	
	31S121722	STRIP, terminal: 2 terminals; mounting lug; #3 12 req'd
	31S490140	STRIP, terminal: 1 terminal; #1 Gnd; 10 req'd.
	31S121702	STRIP, terminal; 3 terminals; #1 Gnd.
	31S122538	STRIP, terminal: 4 terminals; #2 Gnd.
	4C82418B18	WASHER, nylon; 3 req'd.
	4A80236	WASHER, finishing; 10 req'd.
	1V80787A27	HOUSING & CONTACT ASSY incl.: 1V80789A26 HOUSING 41A82093A02 SPRING, compression; 3 req'd. 29S132531 LUG, solder: 3 req'd. 4A82094A01 WASHER, special 6 req'd. 3S2902 SCREW, machine: #2-56 x 3/16"; 3 req'd 39A82092A04 CONTACT; 3 req'd. 14B82296E01 INSULATOR, slide 2 req'd. 64B83648H01 PLATE, cover: 2 req'd. 41A83572H01 SPRING, conical: 2 req'd. 3S136554 SCREW, tapping: #2 x 1/4"; 8 req'd.
	[illegible]	MOUNT, rubber; 4 req'd.

MOTOROLA

NICKEL-CADMIUM BATTERY KIT

MODEL NLN6682A



1. INTRODUCTION

The Model NLN6682A Nickel-Cadmium Battery Kit is a rechargeable power source for the H23FFN Series "Handie-Talkie" ® FM Radio.

The battery consists of 12 hermetically sealed cells connected in series to provide a nominal 15.6 volt output. The cells are enclosed in a molded plastic case.

2. CHARACTERISTICS

The voltage of a nickel-cadmium battery remains approximately constant under load until the battery approaches the discharged condition. At this time, a marked decrease in this voltage occurs and the discharged condition (0.92 v per cell) is reached abruptly. Metering to determine the state of charge of this type of battery is difficult and is not normally performed. A general characteristic of all rechargeable batteries in storage is self discharge. If the battery is used after unknown periods of storage, it is recommended that it be charged for 16 hours using a Model NLN6684A or NLN6685A Battery Charger.

CAUTION

Avoid accidental short circuits. Sustained high rate discharges will damage the battery.

3. MAINTENANCE

The battery cells will never require addition of electrolyte. The only maintenance required is recharging the battery and keeping the contacts clean.

The Motorola Model NLN6684A or NLN-6685A Battery Charger is recommended for charging this battery. The use of other chargers, unless approved, will void the battery guarantee and may result in permanent damage to the battery. Follow the charging instructions which accompany the charger.

WARNING

Do not discard batteries in fire as they may explode.

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4. STORAGE

The battery may be stored at room temperature, in any state of charge without damage. The batteries are subject to self discharge however, and should be recharged after extended storage.

5. BATTERY WARRANTY

a. Service Life Warranty

Any battery failing due to defects within one year will be replaced without additional cost. The battery is considered defective if:

(1) It fails to deliver 80% of its rated capacity.

(2) It develops apparent leakage.

NOTE

Capacity for the purposes of determing liability under the provisions of this paragraph shall be determined as follows:

(a) The battery shall first be completely discharged through a 65 ohm resistive load until its load voltage is between 9 and 12.0 volts.

(b) It shall be charged for 16 hours using an approved charger (NLN6684A, NLN6685A or equivalent model) at the full charge rate.

(c) It shall then be discharged at 68° F through a 65 ohm resistive load to its 12 volt discharge state.

(d) The time required to reach the 12 volt discharge state must exceed 60 minutes for 100% capacity.

b. Battery Replacement

If at any time during the service period, the battery fails to deliver 80% of rated capacity (48 minutes) when determined as specified above, consult only your nearest Motorola Service Representative for further instructions.

c. Limitations to Liability

The Manufacturer's Guarantee becomes VOID if:

(1) Equipment other than that approved by the manufacturer is used to charge the batteries.

(2) Charging is done at temperatures greater than 122°F without proper instructions from the manufacturer.

(3) Batteries are used in equipment or for other services for which they were not intended.